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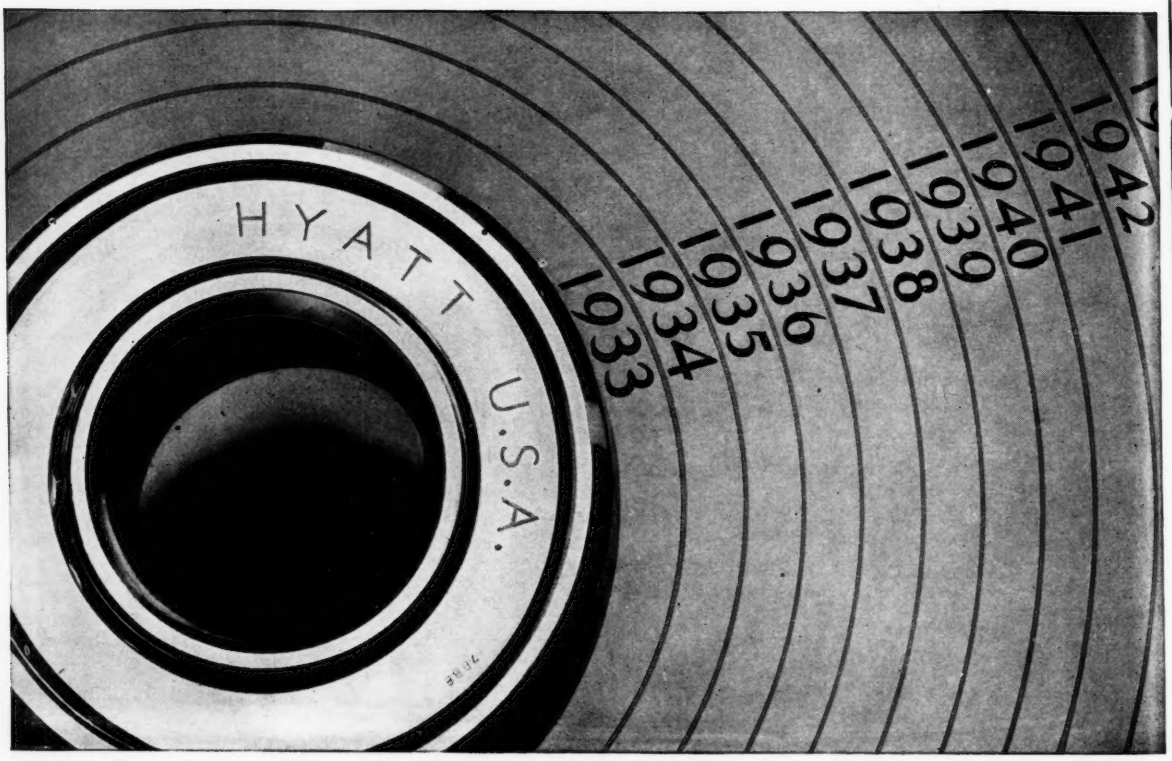

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AGRICULTURAL ENGINEERING

Volume 14 OCTOBER 1933 Number 10

The Real Effects of Mechanization on Wheat Production[1]

By Leonard J. Fletcher[2]

A SURVEY of current literature dealing with world economic matters, more especially agricultural, indicates that farm mechanization is considered the modern bad boy, upsetting profound predictions of the last generation and blocking the way to a return to the "good old days," when there was plenty of work for everyone on the farm. An indication of this viewpoint is expressed in the leading article, entitled "The Course of the Agricultural Depression in 1931-32," by George Pavlovsky, in the January 1933 issue of the International Review of Agriculture, Rome, which states: "Yet, in its revolutionising effect upon the agricultural industry, more important still was the development. . . . . .of the tractor. Combined with the harvester-thresher, the tractor, since the war, has been certainly one of the most important factors in the structural transformation of agriculture and in the creation of those maladjustments and dislocations which are largely responsible for the present depression." This writer goes on to compare the tractor and its influence on present economic balance with the railway and steamship as it affected agriculture in the latter part of the nineteenth century. There is no indication in this article that mechanization is considered anything more than an upsetting force.

Regardless of our desires in the matter, there is now one factor in human relationships which must be reckoned with, that is, change. *New problems* will not be solved by using *old answers*. Progress consists of continuously solving the problems of today which arise from the solutions of the problems of yesterday. Thus farm mechanization has helped to successfully answer a problem of yesterday, namely, the fear of scarcity. We must look forward for the solutions of the new problems which farm mechanization has created.

[1]Paper presented at the World's Grain Exhibition and Conference, at Regina, Sask., Canada, July 26, 1933. (NOTE: Mr. Fletcher was the official representative of the American Society of Agricultural Engineers at the Conference.)

[2]Agricultural engineer, Caterpillar Tractor Co. Mem. A.S.A.E.

The usual discussion on the effect of mechanization on wheat production includes such material as the increased acres handled per man-hour, the release of workers from agriculture, increased investment per acre in machinery, increased use of power per acre, and the like. It is the purpose of this paper to present some of the effects of mechanization which are not normally included in such discussions.

Let us first examine the much discussed increase in labor efficiency due to mechanization on the farm. From a recent publication of the U. S. Department of Agriculture, entitled, "Power and Machinery in Agriculture," (Misc. Publication No. 157-April, 1933) there is secured the following data:

"One hundred years ago the labor requirements for the producing of one acre of wheat, 20-bu yield, was 57.7 h of man labor and 26 h of horse labor. For producing the same acre of wheat in 1930 in the Great Plains area of North America, there was required 3.3 h of man labor and 2 h of tractor labor." The usual conclusion from such information is that a man in 1930 can farm 17 acres with the same expenditure of man labor as was devoted to one acre in 1830.

Let us look more closely at these figures. How about the total energy required to produce this acre of wheat regardless of whether this energy is furnished by human or animal muscles or gasoline? Quoting the abovementioned bulletin, on page 11 it states: "As a source of power a 1200-lb horse is equivalent to about eight 150-lb men." The average tractor used for wheat production in the Great Plains area will average about 30 hp. It is therefore possible to calculate the equivalent man-hours of labor devoted to the growing of an acre of wheat by man labor and by tractor labor. With man labor, this would be 26 h of horse labor times 8, plus the 57 h of man labor, or 265 equivalent man-hours. With the tractor we would have two 30 hp-hr multiplied by 8, plus the 3.3 h of direct man labor, or 483 equivalent man-hours. Thus it is evident that there is not less, but actually more energy per acre being devoted to the growing of wheat today on a

There are six 8-ft rod weeders in this outfit, making a 49-ft cut and covering 330 acres every 24 h—on the 6,000-acre farm of Henry Sheffel in Montana

mechanized farm than there was in the early days of hand production.

While this expenditure of additional energy has made possible the farming of acres unsuited to hand production, its greatest contributions are as follows:

1. A tremendous reduction in the laboriousness of the work. Formerly the farmer was the *source* of power when swinging a scythe or a flail; now he is the *director* of power when driving the tractor or managing the combine.

2. Fewer hours per day and per year; in fact, almost a complete liberation of the work of women in the field, and a great reduction in the work of younger children.

3. A better quality of products. It would very likely not be possible now to market grain for food if it had been threshed by the treading of animals.

To present another viewpoint, let us examine the case of a family growing wheat in the Great Plains area where land is relatively cheap and fields are level and well adapted to the use of the tractor and combine. It is not at all uncommon to find a family producing upwards of 500 acres of wheat and handling about the same area in summer fallow. They use a tractor, a one-way disk plow and duckfoot cultivator, grain drills for seeding, and a combine for harvesting. Their total investment in the machinery will be about $5,000.00. Assuming that the farmer has a son who will help him during the harvest season, he can handle the entire job of growing and harvesting the wheat himself, with the possible exception of hiring the trucking of the grain from the combine to the elevator or farm storage. The farmer will put in about 1,200 h with his tractor during the year. Owing to the need for doing some of the work, such as plowing stubble and cultivating summer fallow in the least possible time, the tractor will be operated day and night for some 20 or 30 days. Including the miscellaneous care of the equipment, about 1,400 h will be put in on this job by the father and son.

It thus appears as though less than three hours of labor produces an acre of wheat. There are cases where, with large machines, an acre has been produced with less than one hour of man labor.

The Element of Labor Involved in Farm Mechanization

Now look at the other side of this picture. This farmer has invested $5,000.00 in equipment. Assuming this equipment to last 10 years, this means $500.00 a year for equipment. Fuel, lubricating oil, parts for machines, general supplies and the like, will equal about $750.00. Here is $1,250.00 which this farmer is expending each year. But who gets it? If you trace these dollars back you will find that they buy mainly one thing—labor. The iron and steel in his machinery is mined by labor, transported by labor, manufactured by labor. Even back of that, labor built the railroads, the mining machinery, and the machines in the factory. Altogether his $1,250.00 per year translates into from 2,500 to 3,000 h of labor. Therefore, to produce this 500 acres of wheat there has been expended at least 4,000 h of labor—1,400 h by the farmer and his son and 2,600 h by his assistants in the factories, mines, oil fields, railroads, etc. Very true, a total of 4,000 h of labor to produce 500 acres of wheat is a great accomplishment when compared to hand production, or results with the older types of grain-producing machinery. But the simple fact that much of the present labor employed to produce the crops on mechanized wheat farms is engaged in so-called non-agricultural occupations, is at least part of the answer to the paradox of the much quoted greatly increased productive efficiency, with comparatively little increase in total production.

Farm mechanization has made many real changes in our agriculture, but the men who count hours of labor from statistics at their desks seldom see the real change. Many of those who write of "hours" and "labor" know little about real physical effort. They lump all kinds of effort together and call it *time*—an hour is an hour. The actual changes brought about by farm mechanization have as much to do with changing the *way* the farmer's hours are employed as the *results obtained* from his hours of labor.

Many of the readers of this article have pitched hay and grain bundles in the hot sun and later worked behind a hay loader or operated a combine. They have milked by hand and later operated a milking machine. They have chopped holes in the ice so the stock could get their supply of water, and later started the pumping engine in the barn. The real contribution that farm machinery has made is not alone reducing the *amount* of time actually spent in production, but *how* this time is spent in terms of human toil.

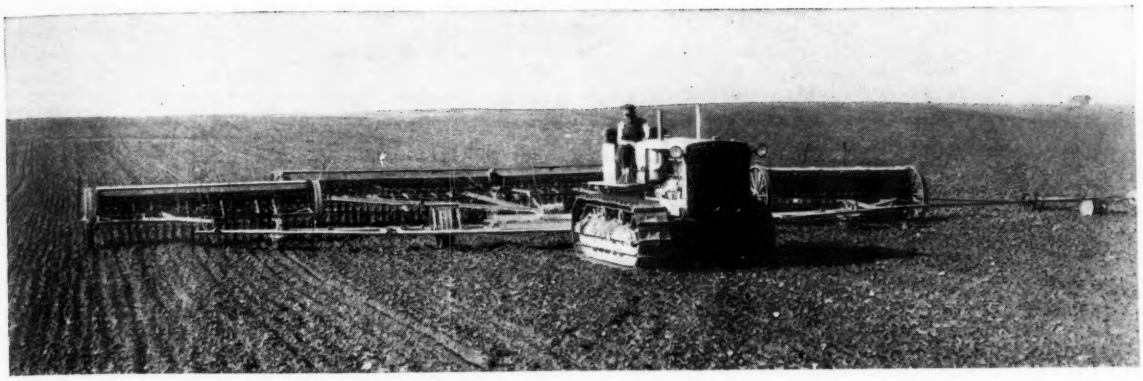
How Farm Mechanization Liberates Farm Family Workers

In the 1932 U. S. D. A. Yearbook of Agriculture, page 498, there is a table showing the changes that have taken place in the number of agricultural workers in that country. It is shown that there were 1,015,000 fewer males over ten years of age engaged in agriculture in 1930 than there were in 1910. Let us examine further. We learn that but 8 per cent of this decrease is in *paid* agricultural workers and that 92 per cent of the decrease is in *unpaid family* workers. In other words, farm mechanization can be largely credited with the liberation from toil of nearly one million farm family workers. Let us visualize what this really means. In the earlier day of hand production, the work of the younger children and old people was necessary to handle the ever-recurring peak loads in the field. Without doubt this great group of unpaid family workers, now relieved from work in the fields, is largely made up of those younger children and old people. Farm machinery to them meant better education, a better physical start in life, and relief from toil in old age.

The government reports, in comparing hand and modern machine methods in wheat production, have the same brief statement, "man labor," over the column which indicates 57.7 h per acre with hand methods and the 3.3 h with machine methods. Let us study briefly just what these hours meant to the farmer. Hand methods may be translated into long hours behind a walking plow, to be followed by wearisome hand sowing, walking many miles each day over the soft soil. This is followed by the terrific toil of hand cutting and binding, and then threshing with flails. Practically all of this labor demanded every daylight hour of the farmer's time, as well as a tremendous expenditure of muscular energy. There was no opportunity in this life for reading of farm papers, attending meetings for the betterment of the farming industry, or taking advantage of any of the opportunities for recreation or educational advancement now afforded the wheat farmer.

Let us see how the 3.3 h is used. Not one minute of this is devoted to walking over the fields—plowing, disking, and harrowing all done from the seat of a tractor or a machine. "Combining" the grain means standing under a sun shade if desired, and manipulating the controls of a power-operated machine.

While the sociologist likes to dabble with the idea that the machine is enslaving the man, a week in the harvest fields of 75 years ago, followed by a week in the harvest field of today, would quickly disillusion this individual and cause him to see rightly that the



A 50-hp tractor pulling 54 ft of grain drills on land operated by the Fairway Farms Corporation of Montana

farm machine is liberating the human race from the burden and toil of producing food.

Farm mechanization has completely spoiled some of the splendid prophecies of the earlier days. It is doubtful whether any agricultural theory has so materially affected the lives and work of so many people as that propounded by Sir William Crookes before the British Association for the Advancement of Science at Bristol in 1898. He proved quite convincingly that the next generation would see a world starving for wheat. In reference to the United States of America, he said: "It is almost certain that within a generation the ever-increasing population of the United States will consume all the wheat grown within its borders, and will be driven to import; and, like ourselves, will scramble for a lion's share of the wheat crop of the world. This being the outlook exports from the United States are only of present interest, and will gradually diminish to a vanishing point."

If a seer could have arisen at this point in Sir William's address and stated that in 1933 the government of the United States would pay its wheat producers to reduce acreage to avoid the building up of surplus, the London insanity Commission would soon be examining an unemployed seer.

Concerning Canada, Sir William Crookes' statement includes: "Expectations have been cherished that the Canadian Northwest would easily supply the world with wheat, and exaggerated estimates are drawn as to the amount of surplus land on which wheat can be grown. The most trustworthy estimates give Canada a wheat area of not more than 6,000,000 acres in the next 12 years, increasing to a maximum of 12,000,000 acres in 25 years." And, in 1932, Canada harvested over 27,000,000 acres of wheat—over twice the maximum predicted in 1898. As late as 1917 the book, entitled "Mankind at the Cross Roads," by East, was being widely quoted as indicating a period of scarcity just around the corner. Sir William Crookes' warning was echoed by leaders in North America. Agricultural experiment stations, colleges, and the farm press placed themselves squarely behind the program of increased production. The accomplishment of this great army of faithful scientific workers, as reflected in improved field practices, and livestock production, pest control and ability to farm the desert, while now somewhat eclipsed by the black cloud called "surplus," will nevertheless take its rightful place in history as one of the greatest scientific achievements of all times. The prophets of a generation ago could not possibly foresee this tremendous influence of mechanization.

Just as the fear of scarcity has been abolished by the plague of plenty, they both are now being replaced by the first move toward a sane utilization of productive capacity balanced with consumption demand.

For centuries the world has struggled to provide goods and services to insure against famine and provide the other necessities, and some of the conveniences, of life. During this struggle there was work for all. Look in any direction, there was a job to be done and as many hours per day to be devoted to it as the worker was willing (or unwilling) to spend. We are now entering a second era where we must learn to use the goods and services which the centuries of toil have taught us to provide. Mechanization has so terrifically accelerated the last few years of this era of production that we have popped out into the sunlight of plenty, before we had an opportunity to provide ourselves a means of preventing sunburn.

The ability to do various tillage, planting, and harvesting operations quickly, and at the proper time, is, perhaps, the principal contribution of farm mechanization. Millions of acres of land now producing wheat could not be handled by hand methods. In the case of many of these areas, seeding must be accomplished within a period of ten days. Summer fallow operations, for the retaining of moisture, must be accomplished within a period of a week or ten days or a serious loss of moisture results. It is the general experience of all nations where hand methods are employed in farming, that the agricultural workers crowd together on the most productive soil easily worked by hand, and engage in a pitiful competition with nature, always in the shadow of starvation due to drouths or floods.

Mechanization has caused a change in the size of farms. The 1929 census of the United States disclosed decreases in numbers of farms of the size which has been long regarded as ideal, namely, 100 to 174 acres. From 1920 to 1930, in that country, there was a 7 per cent *decrease* in farms of 100 to 174 acres; while there was a 7 per cent *increase* in farms of 500 to 1,000 acres, a 19 per cent *increase* in farms from 1,000 to 5,000 acres and a 26 per cent increase in farms over 5,000 acres. Nineteen per cent of the acres harvested in 1929 were from farms of over 500 acres in size.

Professor W. E. Grimes, of Kansas State College, states in the January 1931 issue of the Journal of Agricultural Economics: "When these possibilities (modern machine production) are considered, both from the standpoint of what farmers are now doing and from the standpoint of what can be done, it seems probable that the future size of the typical farm in the western wheatbelt will be considerably in excess of a section and possibly may average two to three sections. There are many efficient farms of three and four sections operated by a single family and from one central point as one farm. If one attempts to describe the most efficient unit for this region, he finds himself dealing with at least 2,000 to 3,000 acres and possibly somewhat more, particularly if livestock is included and a portion of the land is a native pasture."

In the very recent bulletin entitled, "Cost of Producing Farm Products in the Prairie Provinces", prepared by the Dominion Experimental Farms, it is shown that the cost per bushel of wheat decreases from 79½c on a half-section, horse-operated farm to 51.1c on a three-section, tractor-operated farm. On farms of a section or larger, the most economical production was secured with a tractor and combine. This bulletin contains a valuable analysis of the management of animal and mechanical power in grain production outlining the conditions for which each type of power is best adapted.

Mechanization is making possible the farming of a larger area by the farm family. It is providing a firmer foundation for a substantial prosperous family life in the country. It is relieving the farm home of either the regular or seasonal influx of itinerant farm workers with their usual detrimental influence on the younger members of the household.

Mechanization is a new development. The human race can draw upon some sixty centuries of recorded history. Less than one century, however, has seen the entire development of mechanized agriculture. The animal, as a source of power for the serving of human wants, has had at least thirty and perhaps sixty centuries in which to develop and adapt itself. Any student of biology will readily agree that any change in the efficiency of the animal as a motor must come at an extremely slow rate. The mechanical motor, on the other hand, is capable of rapid improvement. Tremendous changes have taken place during even the past fifteen years. These changes include great improvements in the quality of materials used, such as wear-resisting steels, lighter weight materials with greater strength, and the art of excluding dust from working parts is being developed to a high degree. A design of a new power machine may be born in the minds of an inventor one day and be in the field, at work, the next. In other words, mechanical power is a rapidly developing *variable* as compared to the *constant* of animal power. The instant mechanical power was out of the cradle it was being compared with its sixty-century-old contemporary, the horse. It is no wonder that some of these comparisons did not flatter mechanical power. New developments in the use of the tractor power take-off, in more efficient fuel-burning engines for tractors, in new designs of power-operated machinery, are all tending to make more efficient and profitable this new servant to the farmers of the world.

Farm Mechanization Creates Incentive for Higher Living Standards

Farm mechanization has a direct effect on the demand of the worker for more purchased or produced articles or materials to satisfy his desires. It has been my observation that, where an agriculture employs simple hand production methods, it is accompanied by simple desires on the part of the workers. The higher the degree of mechanization, the more the desire of the worker for things which are usually employed as a gage in measuring living standards. We all know that the desire for improvement must come before the improvement itself. That country which is now experienced in machine production in agriculture need not fear competition from other countries where modern farm machinery is placed in the hands of farm workers who literally drop the flail and step onto the combine. These workers will develop a demand for more goods, which means an increase in their real wage, at a rate comparable with their growth in knowledge of how to effectively use their new mechanical servants.

A statement is occasionally made that farm mechanization, with its attendant reduction in production cost, must invariably be accompanied by greater production. This is not the case. Studies made of similar farms in any community clearly show a wide range of productive efficiency where farmers are using practically identical machinery and farming similar areas of similar soil.

It is entirely possible to materially reduce the cost of production without increasing the number of bushels produced per acre. The combine harvester is an example of this fact. It reduces cost per acre, saves more grain than hand methods, but does not increase the number of bushels produced on an acre.

The real product of farm mechanization is *leisure*. Leisure for a better farm life; hours for recreation; hours for giving necessary attention to the problems of the agricultural industry; hours for better attention to health. We are just beginning to emerge from the idea that recreation is sinful and that only in long hours of continuous labor can a man be proud or dignified. Mechanization is bringing to the entire human race not only time for leisure, but a real appreciation for the value of recreation to the human race. A few people seem to think that the human race will destroy itself with this leisure time. Under sane impartial analysis these statements are proven ridiculous and not based on fact. Newspapers cover pages with accounts of one automobile accident, or one mistake, and leave unheralded the thousands who secure profitable enjoyment from motor cars and hours spent following desired employment of leisure time.

The Wheat Farmer as Today's Example of Tomorrow's Producer

The wheat farmer has frequently been held up as an example of one who devotes but 100 to 120 days a year to producing his crop and then loafs the rest of his time. While this may be about the case with many wheat farmers, there are those who devote considerable time, in addition to wheat farming, to the production of livestock or occupations other than farming. This question is frequently asked nevertheless: How can a man possibly expect to make a living with this small amount of labor per year? The trouble with this wheat farmer is that he is too far ahead of his time. He is today's example of tomorrow's producer of every commodity. Most of those who object to the 100-day year of the wheat farmer can find no complaint from the results obtained from these hundred days of work in terms of bushels of wheat. Fifteen thousand bushels of wheat is not an unusual production for this 100-day wheat farmer; enough wheat to give 3,500 inhabitants of North America their regular supply of bread and other cereal foods. Rather these objections are likely prompted by jealousy of a man able to earn a living with a hundred days of work per year, coupled with a great ignorance of the intensive work of these busy days which usually totals more in energy expended than the whole year of most of his critics.

Twelve hundred to 1500 h of intensive effort is expended during these three or four months devoted to wheat production. We are reading much in the press today about the 30-h work week for industry. Fifty such weeks makes a year of 1500 h. It would seem as though we might better use this 100-day-per-year wheat farmer as our pattern for all production, rather than criticize him.

Thus we see that farm mechanization has not only placed the production of wheat on one of the highest planes of productive efficiency known in the manufacture of any product, but it has reduced the work of women and children in the field; it has made lighter the labor of the worker, and it has abolished the fear of food scarcity and has claimed for farm life a measure of leisure time which it so richly deserves and can so effectively utilize.

A Study of 100 Dairy Barns in Wisconsin[1]

By M.A.R. Kelley[2]

THE purpose of this study was to supplement the results obtained in our major tests[3] at Genesee Depot, Wisconsin, with those of ordinary farm conditions. An unusual opportunity for doing this was afforded because of the exceptional weather conditions which prevailed between March 4 and 13, 1932, and that our test barn was located where dairying is a common industry. During this period weather records of 60 years standing were broken. Ice formed on large ponds to a depth of 7 in or more. The weather prior to and subsequently was moderate and normal, hence the comparative results of the sudden change in temperature are clearly shown, for the test barns and nearby farms.

Records from many nearby farms were obtained which were subjected to the same general weather conditions as prevailed at our controlled test barn. Through the cooperation of local receiving plants, we were able to study collectively the receipt representing 100,000 lb of milk daily, collected within a radius of 15 miles of the test barn, and that of a creamery at Madison, approximately 60 miles distant, representing 25,000 lb of milk daily.

The records at the local plants were first studied in the aggregate, and then 100 farm record samples representing approximately 36 per cent of the total daily receipts of each station were studied. This study is of value in establishing the relation of milk receipts with weather fluctuations. Since these data represent more than 500 farms and 70,000 lb of milk daily, the individual effects of many variable factors affecting milk yield will be smoothed out and reveal the dominating effect of the weather. That this effect is not equal at all farms was learned by the study of the individual records. Because of this apparent difference, a personal check was made on many of the farms, which delivered 200 lb or more of milk daily. Because of the distance and lack of time available the farms in the vicinity of Madison could not be visited. However, 55 farms near the test farm were visited, and a study of the barn construction and exposure made. The milk record was then verified with respect to any changes in barn or feed practices which might affect milk yield and the use of the record for our study.

The interpretation or analyses of these data present a good many problems. Consideration must be given to many factors, such as change of number of cows milked or of feed, plane of nutrition, health and vigor of animal, method of watering, light, ventilation, volume of air space and natural shelters, etc. The several years of experience of the author in testing a good many barns during the winter months and under a wide variety of conditions is of much value in this study. "A man's judgment is no better than his information" is a quotation worth repeating. It is admitted that one's judgment must be accepted in some of the conclusions given. However, these conclusions are not given without weighing the apparent evidence from many angles and sources against that of experiments combined with the evidence of results under controlled tests, which will be reported later.

Fig 1 establishes the relationship of milk yields to temperatures during the above-named period (March 4-13, 1932).

A study of the individual records divides them into four or five general classes. It was at once noticeable that the better barns were least influenced by the temperature changes, and that in general the weather had less influence on the Grade A farms than on the other two. Sixty-five out of eighty barns had the minimum yields on the three coldest days, March 7, 8, and 9, and the majority of the maximums occurred on March 5 and 11. It is important to note that on March 11 and 12 almost one-half the cows in barns producing Grade A milk returned to or exceeded their previous yield of this period, whereas only one-fourth of those in the poorer barns returned to the former yields. Better management coupled with better barns yielded better results. The yields in the larger proportion of the poorer barns did not respond as did those receiving better management. These studies reveal conclusively that there is a weather effect, and that this may be modified by barn construction and management.

One must visit the barns to learn the effects of good construction and poor ventilation or management. However, these effects may be revealed by a few typical examples. It is obvious that other factors than the weather, such as change in feed, addition of fresh cows or sale of others, etc., affect the amount of milk sold. The greater uniformity in milk yield in Grade A barns, as shown in Fig 5, led to the personal study of the barns to ascertain the cause of this difference.

Time does not permit the discussion of each barn record or curve, many of which contain interesting points. Some of the most interesting and typical cases can be best illustrated by the groupings shown in Figs 2, 3, 4, and 5.

Fig 2 shows the records obtained from a group of barns, wherein the walls of the stable were built for the most part of different types of masonry construction. In several cases the superstructure was of frame construction but none had a properly installed ventilation system. Barns 80, 86, and 87 would be considered modern and good barns with the exception of faults in lighting, ventilation, or insulation.

Barns 86 and 87 had solid concrete walls with an excessive amount of glass area of over 9 sq ft per cow. Wide temperature variation can not be prevented, and the results of milk yield are clearly shown. Barn 31 had a badly cracked heavy stone wall and an excessive amount of leakage around doors and sills. Barns 68 and 80 also had solid concrete walls and stable temperatures varied with outside conditions.

Cold masonry walls do not appear conducive to maximum milk yields. It is readily apparent that most of these barns in Fig 2 are climatically controlled barns. Concrete walls need not be cold. A test a few years ago in a barn having insulated concrete walls proved the possibility of maintaining a stable temperature of 39 deg with three dilutions of air per hour and an outside temperature of 33 deg below zero.

A comparison of the records of barns 68 and 82, Fig 3, is interesting as they belong to the same owner, the latter being operated by a tenant. Barn 82 is a bank barn poorly lighted and with bad ventilation. A high hill on the north and west gave added protection which undoubtedly prevented wide fluctuations in tem-

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[1]Paper presented at a session of the Structures Division of the American Society of Agricultural Engineers during the 27th annual meeting of the Society held at Purdue University, Lafayette, Indiana, June 1933.

[2]Agricultural engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture. Mem. A.S.A.E.

[3]"A Study of Temperatures in Dairy Stables," M. A. R. Kelley. AGRICULTURAL ENGINEERING, February 1933, Vol 14, No 2.

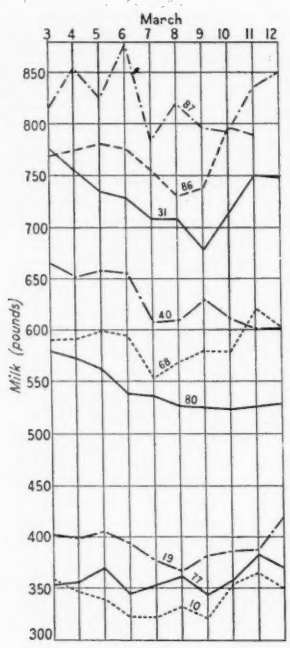


Fig 2. Milk record in cold barns

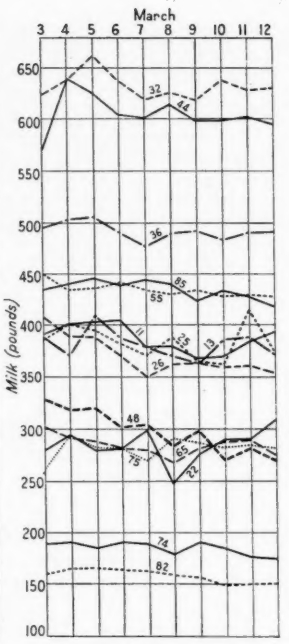


Fig 3. Milk record in warm barns with poor ventilation

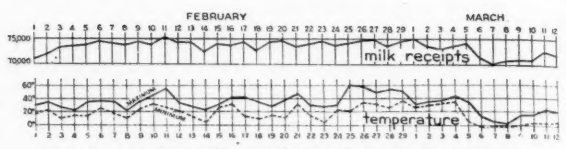


Fig. 1. Daily milk receipts at a condensery as affected by the weather

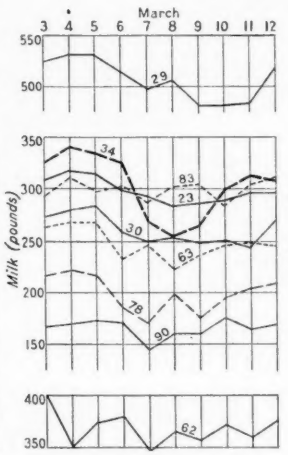


Fig 4. Milk record in barns with variable temperature

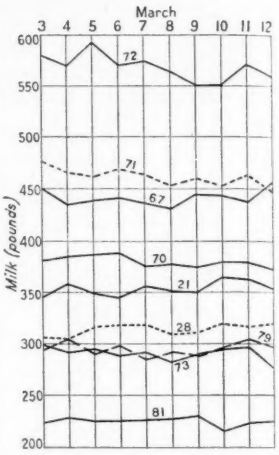


Fig 5. Milk record in barns with fair conditions

peratures. It is noted that the milk yield decreased slowly and did not respond after March 10, as it did in many of the other barns. This depression of milk yield is attributed to lack of vigor, poor stable conditions, and muggy atmosphere. Further evidence of this effect is shown in barn 85 and others in Fig 3. Barn 85 was an excellent barn with a double tile wall having insulating value, but without ventilation except as obtained through doors and windows.

Fig 3 represents a group of barns which were fairly warm, many of which had natural windbreaks to assist in preventing full effects of the cold north winds. It is not claimed that the effect of poor ventilation is conclusive, but bad stable air coupled with other factors usually accompanying it may have been responsible for the failure of the cows to respond so readily in their milk yield. It will be noted that in Figs 2 and 4 milk yields dropped with low temperatures but yields increased on the return of milder temperatures.

The records shown in Fig 4 represent barns which are undoubtedly "climatic barns." They are a fair sample of many of the ordinary farm barns of this state. The accompanying illustrations show that in most cases fairly good construction was used in the superstructure. However, the conditions within the stable varied widely as did their milk yield. Of this group barn 78 was by far the best managed; the cows produced Grade A milk and were kept in good condition. Being in good condition, they responded readily to the milder temperatures. A new cow was added on March 8.

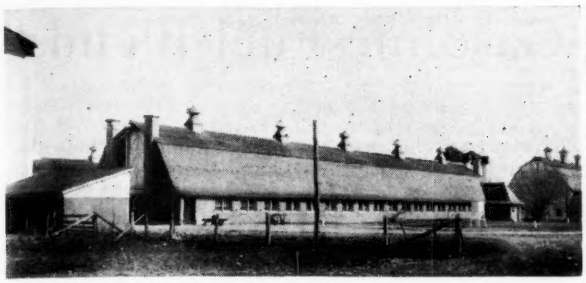
The record of barn 62 is quite variable and does not tell the entire story. This was one of the poorest barns observed. It was very poorly lighted, the light being supplied by two small windows. It was badly overcrowded with large Holsteins and had low ceilings, and because of this conservation of heat was not a big problem. It was fortunate that an opening was cut in the door for the litter carrier, as this together with the hay chute and stairway provided the sole source of ventilation. Stock kept under these conditions are not likely to remain healthy and produce efficiently. It would seem that these cows were capable of producing a much better record, if kept under an environment conducive to a more vigorous condition.

Many barns like 30 are found in this section of the state. This barn was fully exposed to a sweep of northwest winds and shows the temperature effect on the milk yield.

The temperature effect in graph 34 (Fig 4) is plainly evident. There is no question about this barn being cold. The drafts beneath the plank floor, together with the excess leakage around the driveway doors helped to produce a direct temperature effect. There was no change of cows or feed practice during this period. The effect of temperatures on the milk yield was more pronounced because of their low nutrition ration. The walls were single boarded on either side of 4-in studs. The framing was of heavy timber, and a satisfactory barn could be easily made by the installation of a good floor and the additions of insulation and ventilation.

Food energy utilized to keep the body warm can not be transmitted to the milk pail. The cows in many of the barns in this study were being fed on an economy ration. Hence energy demands for heating were often reflected in decreased production of milk. That cows do respond to good treatment and a comfortable stable is shown by the records in Fig 5. Seven out of the nine barns shown were selling Grade A milk. After a study of these records and barns, one cannot doubt the value of temperature control and the beneficial results of clean air in keeping the stock healthy and active. It is shown that the better care attendant to producing high quality milk also produced more milk.

Temperature control alone is insufficient, as will be seen by reference to Fig 3. It was learned that a cool barn with a clean stable air obtained without draft is better than a warm, stuffy barn. Continual breathing of damp stable air in an ill-ventilated stable lowers the vitality of the cow. Habitual exposure to such conditions leads to a lowered tone and an inabil-



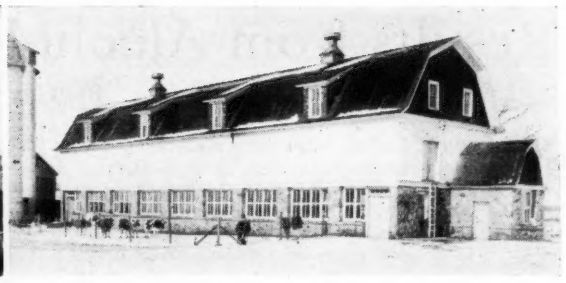


Fig 6. (left) Test barn No 2 which normally houses 100 cows. Fig 7. (right) Test barn No 7

ity to respond at the milk pail and lessens their resistance to disease germs. In fact, in the controlled-test stables many of the cows which were ill returned to former yields or slightly lower in keeping with the usual decline in lactation.

A brief outline of our tests was presented in a previous paper.[3] A picture of these barns will increase the appreciation of the results. Fig 6 is a southern view of the major test barn No 2, which is almost 200 ft. long and normally stables 100 cows. For the purpose of the test this barn was divided by tightly boarded partitions into four stables with 22 cows each. Fig 7 is a southern view of test barn No 7. The rock walls are 20 in thick. In this test eight selected cows were held in a loose pen on the west end of the barn with free access to hay. The lower window sash was removed, so as to permit the weather conditions to prove a dominating influence on stable temperature. At milking time the cows were moved to the stalls on the east end and fed grain and silage. This test revealed many interesting results, but those most pertinent to our discussion are shown in Fig 8.

Fig 8 shows a daily percentage variation from the normal of this period for test barns Nos 2 and 7, as compared with the composite receipts at the creamery, condensery, and Grade A station. It is first noticeable that there was an increase in milk yield in all curves on March 5 with the exception of the creamery, where the increase occurred one day earlier. This appeared to be related to some weather effect, as it was also revealed in the individual studies of many of the barns. There was a rise in temperature on March 4, but the barometric pressure and electronic conditions of the atmosphere prior to the storm must also be held accountable. It will be noted that the fluctuation in milk yield was least in barn No 2 under controlled temperature, with a maximum loss of 2 per cent and often less than 1 per cent, whereas No 7 with wide fluctuations in the temperature showed a loss of 7 per cent or more. It is also noted that the greatest losses occurred on farms delivering milk to the creamery, and that the loss in the better barns producing Grade A milk was second in rank.

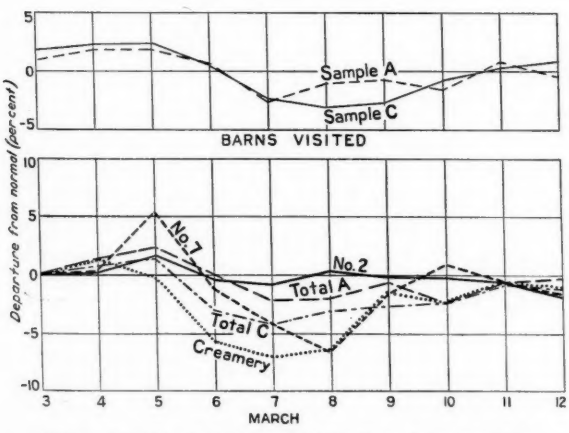


Fig 8. Results of a study of departure from normal milk yield during the cold period

The two curves at the top of Fig 8 represent a sample of the total yields at the two stations. Altogether, of the barns visited, thirty-one delivered milk to the condensery and twenty to Grade A station. The variations in the upper curves reveal that the samples, or barns visited, were a representative part of the respective stations.

SUMMARY

Two general facts are obvious from this study: That weather changes affected the milk yield, which supplements the several other tests of this nature, and that the less known and more tangible factor, that of barn construction, may modify or nullify adverse weather effects and minimize the loss in milk yields. The results as revealed to the author in his study of these barns may be epitomized as follows:

1. Excessive drafts in a stable are dangerous and costly because of the risk of illness and possible loss of stock, and the resultant loss in milk yield.

2. A cool barn with clean stable air obtained without drafts is better than a warm, stuffy barn.

3. Records obtained from fair barns well managed, were better than good barns badly managed.

4. The use of an excessive amount of glass area and excessive leakage of air hinders the control of stable temperatures.

5. It was observed that windbreaks and natural shelters were of value in preventing rapid fluctuations of stable temperature and in reducing milk losses.

6. The largest losses in milk yields occurred in climatically affected barns.

7. Temperature variations as observed in this study are a major factor in fluctuations in milk yields.

8. Most of the farms visited used water bowls to supply water to the cows. It appeared that the milk yields fluctuated more in those barns wherein the cows were turned out to water.

Results from Alcohol-Gasoline Fuel Blends[1]

By Harry Miller[2]

THE use of alcohol as an admixture to gasoline has been suggested as a means of disposing of waste and surplus agriculture products. It is believed that by removing the surplus a higher price will be obtained for agricultural products which in turn would relieve the present economic stress. Whether the use of alcohol in motor fuel is feasible has in the past few months received considerable attention. Those arguing against the idea have contended that alcohol is too expensive and that the motorist should not be penalized with the additional burden of relieving the farm surplus problem. In view of a much needed increase in markets for agricultural products, the problem should not be dismissed until it has been thoroughly investigated.

The Department of Agricultural Engineering at the University of Idaho became interested in this problem, and a project supported by Purnell funds was approved about a year ago. The work has been carried on with the factors of expense and performance always in mind. The promotion of a more expensive and inferior product is certainly not in keeping with sound engineering practice. On the other hand, it is the duty of agricultural experiment station workers to develop and promote any stabilizing influence that can be found to benefit agriculture. If this can be done through the medium of alcohol used as motor fuel, a thorough investigation should be made.

Alcohol is the name applied to a class of substances closely related to hydrocarbons. There are as many types as there are hydrocarbons. A few of the better known alcohols and their boiling points and the corresponding hydrocarbons are given in Table I.

All except methyl alcohol mentioned in Table I can be produced commercially from carbohydrates by fermentation. The production of the higher alcohols, that is, propyl, butyl, and amyl, by fermentation is a very new development. Ethyl alcohol is produced commercially by the action of yeast on glucose. It can be purified to the extent of 95 per cent by distillation. At this point the mixture boils at a lower temperature than the more highly purified product. Consequently chemical means must be resorted to when a more highly purified product is desired. Ethyl alcohol purified to the extent of 99.5 per cent is known as absolute alcohol. Such alcohol will mix with gasoline in any proportion readily, and its use has been recommended widely in the United States.

Alcohol purified to the extent of 95 per cent will not of itself mix with gasoline, except when it constitutes at least 50 per cent of the mixture.

When we began the experimental work at the University of Idaho, it was thought that absolute alcohol would be too expensive. Attention was directed toward finding a method of blending 95 per cent ethyl alcohol with gasoline in any proportion. In using various blends of this type and others, the first difficulty encountered was that of lubrication. After several tests it was found that the addition of ½ per cent oleic acid[3] remedied this trouble. Oleic acid is produced from corn oil. The supply is cheap and abundant. Therefore lubrication need be no obstacle in the use of alcohol-blended fuels.

After exhaustive block and road tests it was found that a blend consisting of 75 per cent gasoline, 20 per cent commercial ethyl alcohol, and 5 per cent higher alcohols was most satisfactory from the standpoint of efficiency. Such a blend, even when made up of third structure gasoline, shows no signs of detonation under conditions that cause premium gasoline to detonate violently. A road test was conducted between Moscow, Idaho, and Newport, Oregon, on a Model A Ford car with the standard 4.22 to 1 compression ratio, and with a special head giving a 5.5 to 1 compression ratio, from which the data in Table II was obtained.

It is interesting to note that at the lower compression ratio the blend gave a slightly lower mileage, while on the higher compression ratio the blend outperformed premium gasoline by 6.6 per cent. The pre-

[1]Paper presented at a session of the Power and Machinery Division of the American Society of Agricultural Engineers during the 27th annual meeting of the Society held at Purdue University, Lafayette, Indiana, June 1933. Research Paper No 100 of the Idaho Agricultural Experiment Station.

[2]Department of Agricultural Engineering, University of Idaho. Assoc. Mem. A.S.A.E.

Table I

Alcohol (General formula, $C_nH_{2n+1}OH$)			Hydrocarbon (General formula, C_nH_{2n+2})		
Name	Formula	Boiling point	Name	Formula	Boiling point
Methyl, or wood alcohol	CH_3OH	66°C	Methane	CH_4	—164.7°C
Ethyl, or grain alcohol	C_2H_5OH	78.4°C	Ethane	C_2H_6	— 86.0°C
Propyl	C_3H_7OH	97.4°C	Propane	C_3H_8	— 38.0°C
Butyl	C_4H_9OH	117.0°C	Butane	C_4H_{10}	+ 1.0°C
Amyl	$C_5H_{11}OH$	137.8°C	Pentane	C_5H_{12}	+ 37.0°C

Table II

Fuel	Mileage	Miles traveled	Compression ratio
"A" gasoline	19.3	300	4.22 to 1
Blend: 75% third structure gasoline, 20% commercial ethyl alcohol, 5% higher alcohols	19.25	300	4.22 to 1
Blend: 75% third structure gasoline, 20% commercial ethyl alcohol, 5% higher alcohols	24.5	300	5.5 to 1
"B" premium gasoline	23.0	300	5.5 to 1

[3]An excellent article on the behavior of oils treated with oleic acid will be found in the Journal of American Chemical Society, January 1933, page 194, "Spreading of Liquids on Solid Surfaces," by R. Bulkley and G. H. S. Snyder.

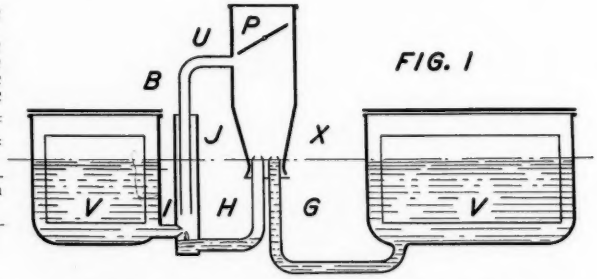


FIG. 1

Fig 1. This shows a double-bowl carburetor used at the German Institute of Fuel Research for handling alcohol and gasoline in any proportion—B, idle tube; G, main fuel jets; H, compensating jet tube; I, compensating jet; J, compensating arrangement; P, throttle; U, idling jet; V, float chambers; X, main air jet

mium gasoline detonated readily on grades, while the blend could not be made to detonate.

While this blend performs very well, it lacks stability at temperatures at which motors are expected to operate. It will separate into two layers at about 20 deg F. We have, however, been successful in finding suitable stabilizing agents which will prevent separation as low as —40 deg F. The stabilizing agents do not interfere with the performance of the blend. However, more study is necessary on the production of these substances, and a report will be issued in case we find something promising. Whether we have a blend stable at low temperatures or not, it does not dismiss the problem. In Fig 1 is shown diagramatically one satisfactory method of using commercial ethyl alcohol, which is practiced extensively in Germany. It consists of a double-bowl carburetor feeding into the same air stream. One bowl is connected to an alcohol supply and the other to a gasoline supply. This arrangement permits the use of commercial alcohol very readily. The jets may be so arranged that alcohol and gasoline may be burned in any proportion. Another arrangement, consisting of two standard carburetors connected in parallel through a Y manifold, was tried but was very unsatisfactory from the standpoint of anti-knock effect.

Evidently it is necessary to thoroughly mix the two vapors in the venturi tube. According to our results, 20 per cent alcohol of the total amount of fuel consumed is most efficient. This is substantiated by a report of Professor E. Hubendick of the Royal Polytechnic Institute, Stockholm, Sweden. Fig 2 shows the relation between power output and heat unit consumption per horsepower-hour for varying amounts of alcohol. Fig 3 shows the relation between alcohol content and number of heat units per horsepower-hour at a constant load of 40 hp. Both graphs indicate that a mixture containing about 20 per cent alcohol is most efficient.

The handling of two fuels may be objectionable to motorists, but in case of tractors it would be no more difficult than the former practice of using water with hydrocarbon fuels. When kerosene is burned, three tanks are needed—for kerosene, gasoline, and water. With such tractors instead of using water as an anti-detonant, why not use alcohol? Commercial ethyl alcohol has all the anti-knock qualities of water, and it has the additional advantage in that it is a fuel. With gasoline tractors it would merely be a question of putting on a double-bowl carburetor and another fuel tank of about one-fifth the capacity of the gasoline tank. The compression ratio could then be raised which would give higher efficiencies, and thus warrant a higher price for alcohol than could be paid for gasoline. If alcohol can be used as a means of improving performance when used in connection with gasoline, a higher price for it is justified.

In using alcohol in addition to gasoline there are three courses open: (1) Blending absolute alcohol with gasoline; (2) blending commercial alcohol with gasoline through the use of blending agents, and (3) using a double-bowl carburetor and two fuel tanks, with commercial ethyl alcohol.

These three methods have been tested by the Department of Agricultural Engineering at the University of Idaho. The first forms a stable mixture, and this has been used extensively in Europe. Objections to it are that it will separate when small amounts of water are added. It is claimed that it will absorb sufficient moisture from the air to cause separation. Alcohol is hygroscopic, but it is apparently protected when mixed with gasoline; according to Professor Hubendick, no such troubles occur with ordinary care.

A mixture containing 10 per cent of absolute alcohol was tested on a grade at Lewiston, Idaho, with a variation in altitude of about 2000 feet between the points where the tests were made, a distance of 7.8 miles. The consumption was 1950 cc compared with 2050 cc for regular gasoline and 1910 cc for premium gasoline. The test was conducted with a Model A Ford car equipped with a head giving a compression ratio of 5.5 to 1. The anti-knock properties of the blend was between that of the regular gasoline and the premium gasoline of the same brand. On the basis of this test 47 per cent more could be paid for alcohol over gasoline.

A blend made up of commercial alcohol blending agents and gasoline has the advantage of better anti-knock properties over a blend of absolute alcohol and gasoline, due to the water content of the alcohol. As has already been pointed out, the performance of this blend with a 5.5 to 1 compression ratio, gave mileage 6.6 per cent better than premium gasoline, even when made up from third structure gasoline, and 26.9 per cent better than ordinary gasoline. We have not found the maximum permissible compression ratio with this blend. However, according to Professor Wawrziniok, of the German Institute of Fuel Research, a mixture of 20 per cent commercial ethyl alcohol will permit of compression ratios as high as 8 to 1 with designs that knock at a 4.5 to 1 ratio when gasoline is used. Fig 4 shows the relationship between the compression ratio and thermal efficiency of an ideal engine and the per cent increase in efficiency as the compression ratio is increased over 4.5 to 1. According to this curve an increase in efficiency of 15 per cent may be expected by raising the compression ratio from 5.5 to 1 to 8 to 1. According to our tests a 20 per cent blend will perform 6.6 per cent better than premium gasoline on a 5.5 to 1 compression ratio. Improvements of 22.4 per cent over

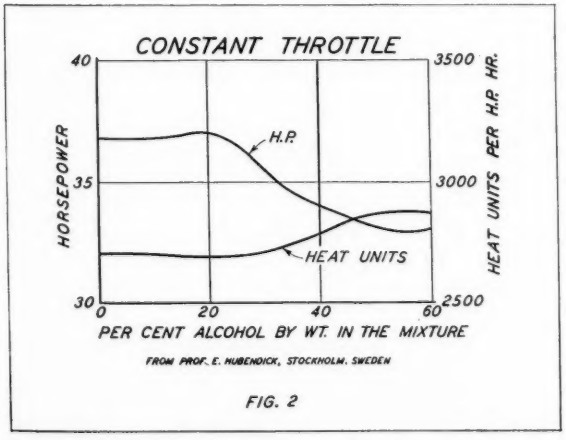


FIG. 2

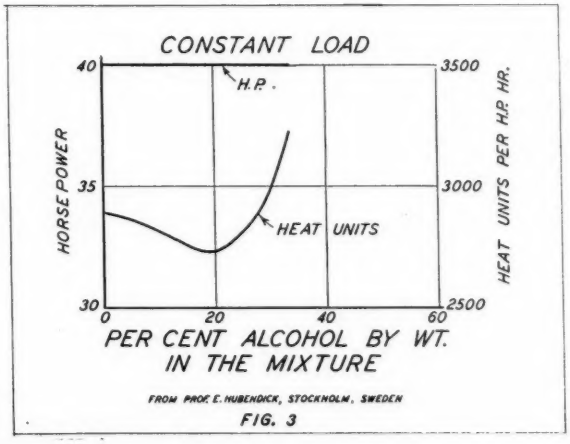


FIG. 3

premium gasoline are therefore possible. Such performance is obtainable by using ordinary gasoline which is 8.8 per cent cheaper than premium gasoline. Using these figures as a basis, 95 per cent alcohol could sell 163 per cent higher than gasoline when used in that way.

The third method of using alcohol is by the use of a double-bowl carburetor. This method is probably the easiest to put into practice. With proper mixing, performance equal to that of a blend, such as referred to earlier in this paper, may be obtained. Suitable carburetors and high-altitude heads or extra long pistons are available for nearly all tractors. The handling of two fuels on tractors is not objectionable. Ten per cent commercial alcohol burned with ordinary gasoline results in performance equal to or better than premium gasoline. Premium gasoline sells at two cents higher than ordinary gasoline. On this basis alcohol could sell at twenty cents more per gallon than gasoline with existing compression ratios.

Let us now consider the general objections made against alcohol. It is claimed by some that, when alcohol burns in a deficiency of air, acetic acid forms just as carbon monoxide forms when gasoline burns in a deficiency of air. Under some conditions this is true, especially in the presence of copper. Acetic acid has a very corrosive effect on iron, and should it form in the combustion chamber the motor would be ruined within a short time. However, according to Professor Hubendick, acetic acid does not form in presence of benzol or gasoline. According to the results of his experiments, should there be a deficiency of oxygen, ethane (C_2H_6) will form which is a hydrocarbon of the paraffin series and is not corrosive. He further reports that motors burning blends containing as much as 25 per cent alcohol show absolutely no wear over motors burning gasoline. This objection in case of blends is therefore without grounds.

Another objection is that alcohol has a corrosive effect on metals used in the construction of fuel tanks, lines and carburetors. Professor Wawrziniok conducted a series of tests on various metals, namely, iron, zinc, lead, aluminum, steel, and tin. Specimens of 100 square centimeters in area were immersed in the fuel for a period of 580 days; Table III shows the loss in weight in milligrams of these specimens. The loss in weight due to corrosion of the various fuels was, except in the case of tin, more from gasoline than from alcohol. These results prove definitely that no excessive corrosion may be expected from alcohol.

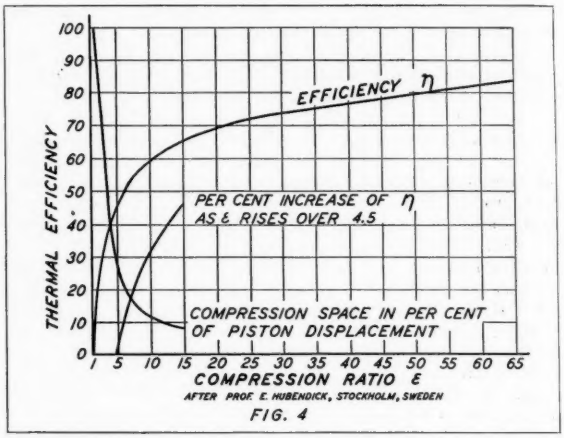
Another objection frequently made is that lines and nozzles frequently become clogged. According to the Swedish reports this trouble only results after a motor has been used with gasoline. The gum which occurs abundantly in highly cracked gasoline deposits on the walls of the fuel tank. Upon switching to an alcohol-blended fuel, this gum goes into solution and is deposited in the nozzles. In Sweden the practice of thoroughly cleaning the tank with alcohol before the first filling of a blended fuel is said to be rigidly followed. This is no serious drawback to such a fuel.

Starting difficulties have been reported. In our own tests no such difficulties have been experienced. The Keystone Steel and Wire Company operating a fleet of

Table III. Corrosive Action of Various Fuels*

Fuel	Iron	Zinc	Lead	Aluminum	Steel	Tin
Benzol	28	0	66	10	0	17
Ethyl alcohol	17	0	37	0	0	28
Gasoline	43	0	98	9	0	17
Dapolin**	68	0	160	0	0	17
Methyl alcohol	17	54	4000	22	22	29
Ethyl ether	227	102	17	0	0	0

*After The German Institute of Fuel Research
**30 per cent alcohol; 70 per cent gasoline.


THERMAL EFFICIENCY
EFFICIENCY η
PER CENT INCREASE OF η AS ε RISES OVER 4.5
COMPRESSION SPACE IN PER CENT OF PISTON DISPLACEMENT
COMPRESSION RATIO ε
AFTER PROF. E. HUBENDICK, STOCKHOLM, SWEDEN
FIG. 4

300 cars report no starting difficulties. German and Swedish workers report perfectly normal starting.

It is claimed that should the use of alcohol become widespread, the petroleum industry would be in a better position to supply the raw materials than the agricultural industry. In this connection it is first of all important to note the report of October 1932 of the Federal Oil Conservation Board which reads in part as follows:

"The public must not lose sight of the fact that our reserves are exhaustible and should not be exploited heedlessly. The public interest demands that those reserves should be properly and carefully developed to assure recovery of the maximum amount of oil and gas and their economic utilization.

"There is every reason to believe that new supplies of petroleum will be found, but the fact remains that the number, productivity, and the time when such new fields will be discovered are matters of conjecture. Therefore, unknown reserves are not determinable and may or may not be available when needed.

"Although in this fourth report this Board discussed some of the factors causing revision of estimates of oil supply and pointed out that during the last decade every estimate had required revision upward in the light of increased production factors, nevertheless it is timely to realize the significance which should be attached to well-founded figures showing that at the current rates of production, the equivalent of our present known oil reserves will have been withdrawn from their underground reservoirs in ten to twelve years."

In view of this report alcohol should be used as a possible means of conserving our oil resources. Furthermore, the market for alcohol is at the scene of the production of raw materials from the farm. This gives alcohol the advantage by eliminating the high freight rates charged to petroleum fuels. It is also interesting to note data given by Dr. Gustov Egloff, of the Universal Oil Products Company, in the "Manual of Industrial Chemistry" by Rogers, page 877. Dr. Egloff states, "Whenever the economic urge is present, ethyl or 'grain' alcohol can be produced from this source at the rate of over 300 million gallons per year." Ethyl alcohol would have to be produced from ethylene which has other uses, such as welding in place of acetylene, artificial ripening of fruits, as a raw material for the production of ethylene glycol, and other commodities. This would greatly reduce the amount of ethylene available for the production of ethyl alcohol. The amount of ethyl alcohol available from petroleum sources would therefore be somewhat less than 1.7 per cent of the total motor fuel requirements. Again to produce a gallon of alcohol from ethylene requires 2.44 gallons

(Continued on page 278)

Electric Lights for Supplying Biologically Effective Ultra-Violet Light

By A. R. Winter[1] and I. P. Blauser[2]

IT is a well-known fact that the vitamin D factor is essential for mineral assimilation, growth, health, and reproduction of domestic animals and man. It is supplied by sunshine, certain electric lights, some irradiated feedstuffs, and certain fish oils, especially cod liver oil. When animals are kept in confinement, because of inclement weather or the system of management, it is difficult to secure the benefits of sunshine. Irradiated feedstuffs and fish oils show wide variation in vitamin D potency and are rather expensive and troublesome to incorporate in farm rations. The development of cheap and simple electric light equipment for supplying biologically effective ultra-violet light would no doubt be received favorably by livestock farmers and especialy by poultrymen.

There are many references in the literature which show that certain carbon arc and quartz mercury arc lights are good sources of the vitamin D factor. Goodale[3]; Scott, Hart, and Halpin[4]; Heuser and Norris[5], Winter and Bishop[6], and others have shown that a few minutes daily exposure to a quartz mercury arc light or direct sunshine will supply sufficient vitamin D factor to prevent rickets in growing chickens. The quartz mercury arc lamps are expensive, and the carbon arc lamps produce somewhat of a fire hazard and require special attention.

There are a few electric lights on the market at the present time and others are being perfected which have been designed with the idea of supplying practical sources of biologically effective ultra-violet light. Among these lights are the Mazda Sunlight lamps (S-1 and S-2), Mazda CX lamps, and Glow lamps (G-1 and G-5).

The purpose of this paper is to present the results of biological tests that have been made with Mazda 60-watt CX lamps, G-1 50-watt lamps, and G-5 100-watt lamps.

Trial 1. Three lots of twenty one-day-old White Rock chicks each were brooded in battery brooders for eight weeks. All sources of light were excluded except from the electric light bulb which was suspended in the battery. The chickens could hover against the bulb or get three feet distant from it. The basal ration fed was a good practical all-mash chick ration without vitamin D addition. Lot 1 received the basal ration plus 2 per cent of cod liver oil. A regular 60-watt Mazda bulb was used in the battery for heat and illumination. This lot served as the positive control. Lot 2 received the basal ration, and a 60-watt Mazda CX bulb was used in the battery. Lot 3 received the basal ration, and a regular 60-watt Mazda bulb was used in the battery. This lot served as the negative control. The lights burned constantly during the brooding period.

At the end of eight weeks three birds from each lot were killed and the legs removed and placed in physiological saline solution containing 5 per cent formalin until ready for analysis. The tibia of the right leg was carefully freed of muscle meat and connective tissue, crushed, wrapped in filter paper, and extracted with hot 95 per cent alcohol for 72 hours. The bones were removed from the extractor, dried, and the ash analysis made on the dried extracted bone. The data obtained from this trial is given in Table I.

Trial 2. Five lots of seven one-day-old Leghorn chicks each were brooded for five weeks in batteries which had all sources of light shut out, except that supplied by an electric light bulb in each battery. The vitamin-D-free ration feed was similar to that used by Hart, Kline, and Keenan[7]. Lot 1 (negative control) received the basal ration and was exposed 24 hours daily to a regular 60-watt Mazda lamp. The light was suspended in the center of the brooder and rested against the floor. A wire guard was placed around the bulb to keep the chicks from getting against it. The brooding compartment was about two feet square. The chicks could get close to the source of heat and light or get a short distance away from it. In Lot 2 conditions were the same as in Lot 1, except a 60-watt Mazda CX lamp was used in place of the regular Mazda lamp. In Lot 3 the Mazda CX lamp was used 5 hours daily, and the regular Mazda lamp was used 19 hours daily. In Lot 4 the Mazda CX lamp was used 11 hours daily, and the regular Mazda lamp was used 13 hours daily. Lot 5 (positive control) was the same as Lot 1, except 1 per cent of cod liver oil was incorporated in the ration. At the end of the test five birds from each lot were killed and the per cent of bone ash of the tibia bones was determined as in Trial 1. The results are given in Table II.

Trial 3. Seven lots of ten one-day-old Leghorn chicks each were brooded and fed the same as the birds in Trial 2. Lot 1 was exposed 2 hours daily to a 50-watt G-1 lamp placed outside of the battery with an aluminum reflector background. The birds had a range of distance from the light of 1 to 4 feet. Lot 2 received 4 hours daily exposure to the G-1 lamp. Lot 3 received 4 hours daily exposure to the G-1 lamp, and 1 per cent of cod liver oil was added to the ration. Lot 4 was exposed one hour daily to a 100-watt G-5 lamp with aluminum reflector background at a distance of 4 feet. Lot 5 was exposed 4 hours daily to the G-5 lamp at a distance of 4 feet. Lot 6 received the basal ration and exposure to a regular 60-watt Mazda lamp at all times, the same as all the other lots when not being exposed to the special lamps. This lot served as the negative

[1]Department of poultry husbandry, Ohio State University.
[2]Department of agricultural engineering, Ohio State University. Assoc. Mem. A.S.A.E.

[3]Goodale, H. D., Early growth rates of chickens with special reference to ultra-violet light. Am. Jour. Physiol. 79, 44-60. 1926.

[4]Scott, H. T., Hart, E. B., and Halpin, J. G., Winter sunlight, ultra-violet light, and glass substitutes in the prevention of rickets in growing chicks. Poul. Sci. 9, 65-76. 1929.

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[6]Winter, A. R. and Bishop, F. C., Transmission of ultra-violet light through window glass. Poul. Sci. 12, 9-16. 1933.

[7]Hart, E. B., Kline, O. L. and Keenan, J. A., A ration for the production of rickets in chicks. Science, 73, 710-711. 1931.

Table I.

	Lot 1 Positive control	Lot 2 Mazda CX lamp	Lot 3 Negative control
Average weight at 7 weeks (grams)	430	483	343
Bon ash content (per cent)	43	45	40

Table II. Exposure of Chicks to Mazda Lamps

Lot No.	Time of exposure	Bone ash analysis (Av. of 5 birds)
1	Negative control	36 per cent
2	24 hours daily	46 per cent
3	5 hours daily	39 per cent
4	11 hours daily	46 per cent
5	Positive control	46 per cent

Table III. Exposure of Chicks to G-1 and G-5 Lamps

Lot No.	Exposure	Bone ash analysis (Av. of 5 birds)
1	2 hours daily to G-1 lamp	43 per cent
2	4 hours daily to G-1 lamp	46 per cent
3	4 hours daily to G-1 lamp, and 1 per cent cod liver oil in ration	46 per cent
4	1 hour daily to G-5 lamp	42 per cent
5	4 hours daily to G-5 lamp	45 per cent
6	Negative control	36 per cent
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The Mazda CX lamp consists of a high-efficiency tungsten filament in a gas-filled bulb which is also made of ultra-violet-transmitting glass. The lamp will operate on either an alternating or direct-current circuit. It looks like a regular Mazda lamp bulb but is distinguished by the CX stamp. The 60-watt Mazda CX lamp is suitable for use inside of batteries to supply heat and biologically effective ultra-violet light. Data is presented in Table II which indicates that if the lamp is burned 11 hours daily in a battery without a reflector it will supply the requirements for the vitamin D factor. The data obtained in Trials 1 and 2 agree favorably with reports by the Virginia Agricultural Experiment Station[8]; Miller, Bearse, and Cushing[9], and Porter and Ditchman[10], that 60-watt Mazda CX lamps supply biologically effective ultra-violet light.

The Glow 50-watt G-1 and 100-watt G-5 lamps are low-pressure mercury arc lamps having a low output of visible light. The bulbs are made of ultra-violet-transmitting glass. These lamps require a reactance or transformer for use on alternating-current circuits. On direct-current circuits, they may be operated with a series ballast resistance which can be in the form of a heating element. The G-1 lamp may be wired in series so that one transformer will serve for not more than three lamps when used on a 110 to 120-volt circuit. Table III shows that 4 hours daily exposure to a G-1 lamp under the conditions of the test protected chickens against rickets The use of both oil and ultra-violet light gave no better results than when each one was used alone. Four hours daily exposure to the G-5 lamp at a distance of 4 feet protected against rickets, but one-hour exposure was not quite sufficient.

Negative controls under conditions similar to those in Trials 2 and 3, except that the light bulbs were covered by a metal chimney so that only reflected light from a sheet iron surface reached the birds, have given a bone ash content of 31 to 32 per cent[8]. The negative controls in Trials 2 and 3, where the regular 60-watt Mazda bulbs were not covered, gave a bone ash of 36 per cent. Therefore, it appears that ordinary electric light bulbs give off a little biologically effective ultra-violet light.

[8]Virginia Agr. Exp. Sta. Rpt. 1928-1931, pp. 72-73.

[9]Miller, M. W., Bearse, G. E. and Cushing, G., Irradiation of chicks. Poul. Sci. 12, 21-22. 1933.

[10]Porter, L. C. and Ditchman, J. P., Ultra-violet in the poultry industry. 1932. Publication of the General Electric Co.

CONCLUSION

Mazda CX 60-watt lamps produce appreciable quantities of biologically effective ultra-violet light. The use of one of these bulbs in each compartment of a battery brooder, without a reflector, 11 hours or more daily will supply an adequate amount of the vitamin D factor.

G-1 and G-5 Glow lamps produce biologically effective ultra-violet light. Chickens exposed 4 hours daily to a 50-watt G-1 lamp with aluminum reflector at a distance varying from 1 to 4 feet were protected against rickets. Chickens exposed 4 hours daily to a 100-watt G-5 glow lamp with an aluminum reflector, at a distance of 4 feet, were protected against rickets, and exposure for one hour daily nearly afforded complete protection.

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Considerable incorrect information has been published concerning the cost of alcohol. According to figures furnished by the Power Oil and Gas Company of Spokane, Washington, the processing of alcohol from potatoes costs 6 per cent per gallon exclusive only of the cost of the bond. One ton of potatoes will yield 30 gal of commercial alcohol and 120 lb of carbon dioxide. Three to five dollars per ton is regarded as a very good price for cull potatoes. The carbon dioxide is a saleable product to which could be charged some of this cost. In any case the alcohol would not be over from 12 to 23 cents per gallon.

In case of corn the objection has been raised that the freight on the by-products to and from the alcohol plant would put the method out of question. Machines are in existence that can separate the starch from the other materials, and here is an opportunity for agricultural engineers to make a real contribution by developing machines that will do this on the farm. A bushel of corn contains 32.5 lb of starch which for the most part runs to fat when fed to hogs. By separating this starch and diverting it to other uses, a better grade of pork would be produced.

There is ample opportunity for agricultural engineers to contribute to this problem. The market possibilities should this be commercialized are tremendous. Our annual motor fuel consumption normally is about 17 billion gallons per year. If 20 per cent of this amount were alcohol, it would provide an outlet for the starch content of 2,200,000,000 bushels of corn, or 113,000,000 tons of potatoes. Our natural production of these crops in 1928 was 2,500,000,000 bushels and 14,000,000 tons, respectively. The requirements would be many times in excess of our surpluses and wastes.

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Requirements for the General-Purpose Agricultural Tractor[1]

By A. W. Lavers[2]

THE general-purpose tractor is not a new development, but there are many problems connected with its design yet to be overcome. If the general-purpose tractor is really to be what its name implies, it must do all the work on the farm now done by tractors and horses. Most of the general-purpose tractors sold today will do most of the jobs around the farm, but certainly tractor engineers cannot call the job finished until their tractors will completely displace all other sources of power on the farm.

The cost must be kept as low as possible consistent with strength, life, and good design.

The general-purpose tractor must be a good plowing tractor which means that it must be able to handle the number of plows it is designed for successfully in 90 per cent of the conditions. It must have a hitch which must be balanced so that it can properly handle the plows at plow speed, and yet be safe and have useful power in the lower speeds. The seat must be properly located and comfortable. The controls must be properly located for easy handling of the tractor. The wheels must have proper traction to handle the load without excessive slipping.

For cultivating, planting, and other field operations the tractor must have the qualifications mentioned for plowing plus easy, quick steering, and an engine that can be throttled down to low speeds and yet be flexible at these speeds. The wheels must be spaced so as to go between the rows of the various row crops without doing damage. The clearance under the tractor must be sufficient to avoid damage to the various crops to be cultivated. Vision must be good.

The tractor must be of light weight and have a short wheelbase, and the turning radius must be small, which makes differential brakes essential.

The general-purpose tractor will be used more days per year than other types of farm tractors and will probably run at higher speeds. It should be kept in mind that, if the tractor is to completely replace the horse, it will be used much more in cold weather than heretofore. This means that it must be sturdily built and have at least as many hours' life as the larger tractors.

The engine must be of sturdy construction easily accessible for service work. Tractor operators are gradually becoming better mechanics through their experience with the more modern machinery, and in the future they will do more of their own repairing than in the past. It must be well protected from dirt by a good air cleaner and good seals at all points where dirt can enter. The accessories must be foolproof and sturdy, and not require a great deal of attention. A variable-speed governor is necessary in order that the engine can be throttled down without restricting the power. The engine must be economical in fuel consumption. The cooling system must be adequate.

The transmission must be oil and dust tight, and must be compact. A belt pulley must be provided and must run at standard A.S.A.E. speed. A power take-off must also be supplied according to A.S.A.E. standards.

Wheels must be sturdy and equipped to give good traction. They must be equipped to work in listed as well as flat ground.

The general-purpose tractor of the future will pull trailers and run at high speeds on highways. Rubber tires are necessary for this work, and present indications are that they will be used for field work as well. The brakes will be very important.

The implements used with a general-purpose tractor must be sturdy and of as light weight as possible. They must be built to run at a higher speed than horse-drawn tools.

Changing from one tool to another must be done quickly and with ease.

The general-purpose tractor is a machine which is used for a great variety of jobs and the number of jobs is increasing.

Following are some of the problems which come up in connection with the tractor:

With so many accessories being attached to a tractor and the tractor being used for so many jobs, it is impossible to have all conditions ideal for each job. Therefore, it is necessary that the most important job that this tractor is going to perform be given first consideration, and the other jobs in their order of importance. What is the most important job a general-purpose tractor has to do? What speeds are necessary? What power is needed for different jobs—cultivating, planting, plowing, belt work, hauling? What clearance is necessary? What row spacing is necessary? What fuels should be used and standardized on? What parts and accessories can be standardized on, such as wheels, seat, drawbar location, tools, lights, etc? What sizes of tractors are necessary.

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The Heating of Cotton when Bulked and Its Effect on Seed and Lint[1]

By H. P. Smith[2], M. H. Byrom[3], D. T. Killough[4], and D. L. Jones[5]

DURING the 1932 cotton harvest in northwest Texas a large percentage of the cotton harvested, both by hand and by machine, was piled in the field on the ground (Fig 1). There was an impression among the farmers at the time that piling cotton for periods of two to three weeks before ginning would improve the grade and staple of the cotton, and in addition would afford some protection to the cotton on the inside of the pile from unfavorable weather conditions. Their experience in previous years in piling cotton in the field, however, had been with cotton which was practically free of green leaves and green unopen bolls. Such cotton when piled in the field, regardless of whether it had been harvested by hand or by machine, had not heated when bulked to the point of damaging the lint and seed.

Weather conditions in northwest Texas in the fall of 1932 had caused the bolls to open late and frost had not defoliated the plants by the time machine harvesting began. As a consequence of the lateness of the season, or extension of the growing period, much of the cotton harvested by machinery was immature and contained a high percentage of moisture in the form of green, unopen bolls and green leaves which were mixed with the bolls that had matured. This cotton when bulked in piles in the field in very large quantities soon began to sweat and heat which resulted in damage to the seed and lint. Martin and White[6] found that piling cotton on damp ground caused the cotton on the bottom of the pile to heat and become damaged as a consequence.

Over 400 piles of cotton were counted that had been either hand-snapped or machine-harvested in a few hours drive in the vicinity of Lubbock on November 13, 1932. The size of these piles ranged from 200 to 5,000 lb. In several fields the machine-harvested cotton was piled in windrows about two feet high and two to three feet wide with the sides almost vertical (Fig 2). One farmer had piled about twenty-five bales in five long ricks (Fig 3).

It should be pointed out that the heating of stripped or mechanically harvested cotton when bulked does not result from the method of harvesting but from the condition of maturity of the seed and the lint at the time of harvest. Previous years' experience has shown that well-matured cotton harvested by machinery did not heat to any appreciable extent when bulked in the field.

One large cotton buyer reported having received in 1932 several thousand bales of cotton which had been damaged as a result of ginning the seed cotton while damp. The dampness resulted from green immature cotton that had become damp through sweating when stored in piles in the field, or from the practice of piling cotton on damp ground. In many instances ginners poured kerosene on the gin saws to remove the gum which had collected on the saws in ginning the damp and immature cotton. The use of kerosene, however, is not advisable since it damages the lint and when detected the bale is not insurable.

HEATING OF STRIPPED COTTON STORED IN PILES IN THE FIELD AT LUBBOCK IN 1932

On October 15 a bale of cotton was harvested with a commercial cotton stripper at the Texas Agricultural Experiment Substation No 8, at Lubbock, from a field where 66 per cent of the cotton was open. The percentage of open cotton was determined by counting the number of open and unopen bolls on a given number of plants. The foliage was still green, and approximately 14 per cent of green leaves and 34 per cent green, unopen bolls was collected with the cotton in harvesting. The harvested cotton was piled in the field and left for two months before it was dry enough to be ginned. This pile heated as a result of green bolls and green leaves being mixed with the mature cotton. Fig 5 shows that the temperature on the inside of this pile of cotton on November 4 was 141 deg F, while the air temperature was 61 deg. At noon on November 7 when the air temperature was 73 deg, the temperature of the pile was 149 deg, the highest recorded. During the afternoon of November 7 a "norther" occurred, the wind attaining a velocity of 45 mph. This "norther" caused the temperature of the pile of cotton to drop to 140 deg by five o'clock. A drop of 9 deg in temperature in 5 h shows that the atmospheric temperature has considerable influence on the heating of bulked cotton. Fig 5 shows the range in temperature of the cotton and of the air, from November 4 to 18, inclusive. It will be noted that the temperature of the pile of cotton was considerably higher than the maximum atmospheric temperature. A sample of cotton taken from the inside of the pile on November 8 contained 34 per cent moisture.

Perrin Bean, of Lubbock, mechanically stripped 20 bales of cotton and piled it in the field in piles, which averaged 10 ft in diameter and 4½ to 5 ft in height (Fig 1). Some of this cotton, which was harvested the latter part of October, was found to have a temperature of 130 deg on November 10.

J. L. Snider, of Abernathy, Texas, harvested approximately 20 bales of cotton the latter part of October. This cotton was tramped in wooden pens 17 ft long, 4 ft wide, and 4 ft high. The cotton was rounded up on top making the total height of the piles about 5 ft (Fig 4). The 20 bales were placed in 14 piles. On November 13 the temperature on the inside of one of these piles was 132 deg F, which probably was not the maximum reached. Mr. Snider had dug and left open a hole in the side of the pile about 2 ft deep and 1 ft in diameter. Vapor was flowing from the hole and the vapor on the inside had condensed forming large drops of water.

Another farmer near Lubbock harvested five bales of cotton the latter part of October, with a machine equipped with a bur extractor. The extractor broke open some of the green, unopened bolls and extracted the green and damp cotton, which was mixed with the dry, mature, open cotton. The five bales were placed in a rick 5 ft high, 10 ft wide, and 30 ft long. On Novem-

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[1]Technical Series Paper No 268 of the Texas Agricultural Experiment Station. Released for first publication in AGRICULTURAL ENGINEERING.

[2]Chief, division of agricultural engineering, Texas Agricultural Experiment Station. Mem. A.S.A.E.

[3]Technical assistant, division of agricultural engineering, Texas Agricultural Experiment Station. Assoc. Mem. A.S.A.E.

[4]Agronomist, division of agronomy, Texas Agricultural Experiment Station.

[5]Superintendent, Texas Substation No 8 (at Lubbock).

[6]Martin, J. G. and White: "Handling and Marketing Durango Cotton in the Imperial Valley," U. S. Department of Agriculture Bulletin 458 (1917) p 22.

ber 6 the temperature at one place in the rick was 104 deg, which was probably not the maximum.

A pungent odor of decaying vegetable material was distinctly noticeable on the approach to a heated pile of cotton.

Two bales of open, well-matured cotton was hand-snapped and piled in the field during the week of October 25 on the experiment station farm at Lubbock. This cotton containing no green bolls or leaves was found not to be heating, but it felt slightly damp and apparently was sweating a little.

R. H. Bean, of Lubbock, mechanically stripped 25 bales of cotton which were placed in windrows on the ground. The windrows of cotton averaged 2 ft wide at the base and 2½ ft in height. The sides of the windrows were almost perpendicular. This cotton became damp 12 to 18 in upwards from the ground. None was found to be heating since the width of the windrow was narrow enough to be kept cool by the surrounding air.

HEATING OF THE STRIPPED COTTON STORED IN PILES IN THE FIELD AT COLLEGE STATION IN 1932

In order to study the effects of piling cotton in the field at College Station, Texas, 438 lb of cotton, containing some 20 per cent green leaves and green bolls, was harvested with the Texas station harvester on September 15, 1932, and placed in a pile on a tarpaulin on the ground. Two recording thermometers were inserted in the mass, one, four inches from the bottom of the pile and the other in the center of the pile. Fig 6 shows that the temperature of the cotton at the beginning of the test, as recorded by the top thermometer, was 88 deg F, while the air temperature was 92 deg. Within twenty-four hours the temperature of the pile rose and finally reached a maximum temperature of 138 deg on the fifth day, after which there was a gradual drop. On the sixteenth day of the test the thermometer registered below the maximum atmospheric temperature. The graph shows that for 14 days the temperature in the pile was well over 100 deg, and considerably higher than the temperature of the air.

Tests made on September 16 on the percentage of moisture in cotton bolls, including both mature and immature bolls, showed that 66 per cent of the total weight was moisture. Similar tests on green leaves showed that 75 per cent of the total weight was moisture.

The rapid rise in temperature shortly after storage, followed by a drop and then a gradual rise, was apparently due to heat being lost that had been absorbed by the cotton during harvest. The second rise in temperature was probably caused by heat generated by the presence of moisture in the cotton. The rapidity of the rise was influenced by the percentage of moisture present in the cotton and the atmospheric temperature.

Two thousand pounds of seed cotton containing only a few green bolls and no green leaves was harvested with the Texas station harvester on October 21. This cotton was stored in a house on the morning of October 22. The pile was about 10 ft square and about 5 ft high. Recording thermometers were placed in the cotton at noon on the same day. Fig 7 shows that the maximum atmospheric temperature during the day was 84 deg. When the thermometers were inserted in the cotton, they registered 76 deg. The temperature of the cotton gradually rose to 82 deg during the first four days, after which, as a result of a "norther," the temperature dropped to 66 deg on the sixth day. On the tenth day the temperature was 73 deg, which was five degrees

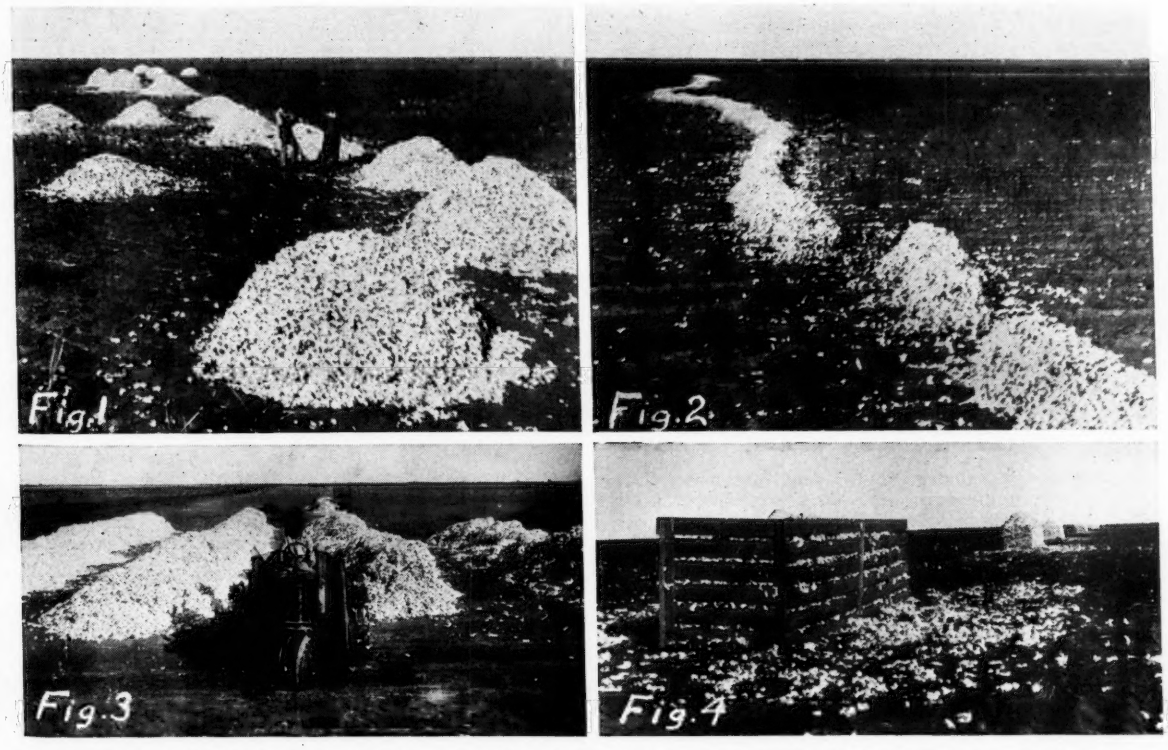

Fig 1. Typical field scene of piled cotton in northwest Texas harvested either by hand snapping or stripping by machines. Fig 2. Typical windrow of mechanically harvested cotton in northwest Texas in 1932. Fig 3. Twenty-five bales of mechanically harvested cotton stored in ricks in northwest Texas. This cotton was well-matured and contained only a few green bolls; it sweated slightly but did not heat. Fig 4. One farmer tramped his cotton in a form. After filling, the form was removed and set up in a new location for another pile

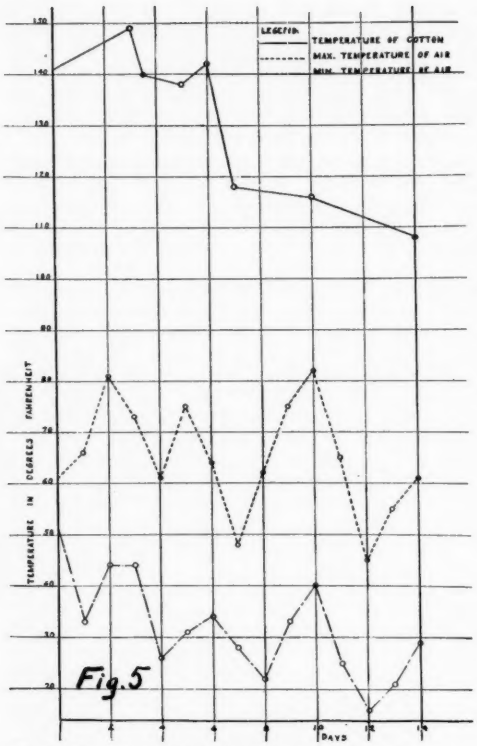

Fig 5. Curves showing temperature of a pile of cotton, and maximum and minimum temperatures of the air from November 4 to November 18 at Lubbock for mechanically harvested cotton containing 34 per cent unopen bolls and 14 per cent green leaves

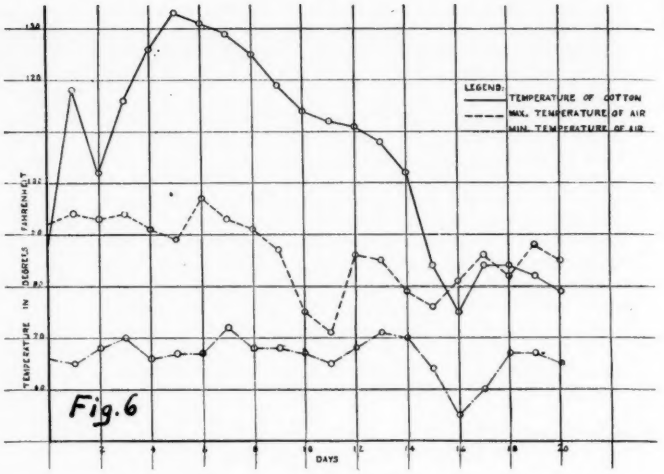

Fig 6. Curves showing the temperature of the cotton and the maximum and the minimum air temperatures for the pile of cotton in the field at College Station containing 20 per cent green leaves and green unopen bolls from September 15 to October 4, inclusive

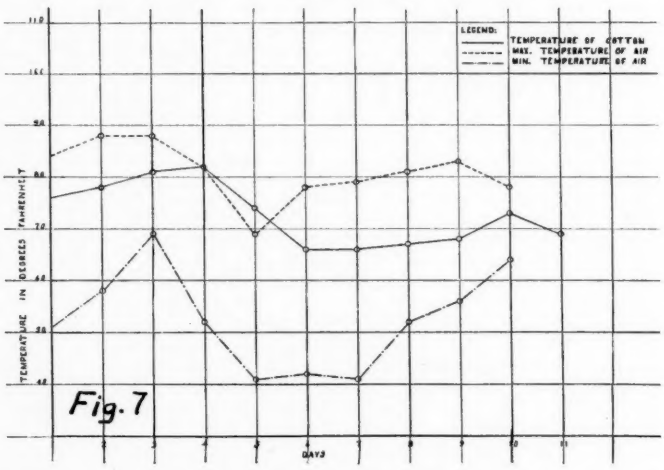

Fig 7. Curves showing the temperature of the cotton containing only a few green unopen bolls and no green leaves, and the maximum and minimum air temperature for the pile of cotton stored in the house at College Station from October 22 to November 1, inclusive

lower than the maximum atmospheric temperature. The temperature of the pile of cotton stored in the house, which contained only a negligible quantity of green bolls, averaged lower than that of the maximum atmospheric temperature.

The factors that cause heating of bulked seed cotton are as follows:

1 Excessive moisture in (a) seed cotton not thoroughly mature and dry, (b) green, unopen bolls, and (c) green leaves and stems.

2 Temperature and humidity of the atmosphere.

3 Piling of cotton on damp ground.

Effects of Heating on Germination of Cotton Seed

Germination tests were made of cotton seed taken from the inside and from the surface of heated piles of stripped cotton and from piles that had not heated. Table I shows that seed taken from the inside of the heated pile at College Station germinated only 4 per cent, while a sample from the surface of the pile germinated 67 per cent.

No seed germinated that were taken from the inside of heated piles at Lubbock, while the germination of those from the surface of the piles ranged from 32 to 64 per cent. Cotton seed from inside of narrow windrows germinated 26 per cent, and from the surface 50 per cent.

It should be noted that the best germination secured for hand-snapped cotton seed, which did not heat when the cotton was piled in the field in northwest Texas, was only 76 per cent. This was probably due to the late maturity of the cotton as a whole, and to the fact that both the early and the late maturing cotton were harvested together.

Brand and Sherman[7] found that when seed cotton was stored for several weeks in piles, both loose and tramped, from 43.5 to 64 per cent of the seed germinated when not affected by heating. When the seed cotton, however, reached a temperature of 111 deg, 5 to 13 per cent germinated, and when the temperature reached 127 to 133 deg, germination was destroyed.

Effects of Heating on Fat and Water Content of Cotton Seed

According to analyses made by the division of chemistry at the Texas station of cotton seed taken from the inside and from the surface of the heated pile of cotton at College Station, it shows that there was less fat in the seed taken from the inside of the pile. Seed from the surface contained 17.21 per cent fat, while those from the inside contained 15.34 per cent. Samples

[7]Brand, C. J. and Sherman, W. A.: "Behavior of Seed Cotton in Farm Storage," U. S. Department of Agriculture, Bureau of Plant Industry Circ. 123 (1919) pp 11-20.

of seed taken from the inside of the pile of cotton bulked on the Lubbock station analyzed 17.30 per cent fat, while seed taken from the inside of the pile of well-matured, hand-snapped cotton which did not heat analyzed 22.48 per cent fat.

Heating of the seed on the inside of the piles of cotton caused the free fatty acids to separate more readily, resulting in the production of a lower grade of refined oil. For example, cotton seed taken from inside of heated piles of cotton at College Station and Lubbock analyzed 9.41 per cent free fatty acids in oil, while the seed which did not heat analyzed only 2.34 per cent.

There was no significant difference in the percentage of water in the seed taken from the inside and from the surface of the pile.

Cotton seed which have been heated are lighter in weight than seed not heated. Table I shows that the seed taken from the inside of the heated piles at College Station, the substation at Lubbock, and the Perrin Bean farm at Lubbock were lighter in weight than seed taken from the surface of these piles. It will be noted that seed from the inside of piles on the J. L. Snider farm were slightly heavier than those on the surface. This may be attributed to the fact that the samples were taken from the pile soon after heating began, and the seed were, therefore, not subject to heating for as long a period of time as the other samples of seed analyzed.

Creswell and Bidwell[8] found that the oil from heated cotton seed is of lower value, having a higher refining loss and producing a lower grade of refined oil.

Malowan[9] found that during heating of cotton seed the sugars and pentosans decrease, while the acidity increases, and the proteins become insoluble in salt solution. As long as the seed did not heat practically no change took place.

Rather[10] in his studies of the changes in stored cotton seed with reference to loss of vitality and availability from the standpoint of the cottonseed oil miller and the livestock feeder, concluded that unless cotton seed heats badly the meal made from it will be as valuable for feeding as meal from unheated seed, but that the oil from even slightly heated cotton seed is worth considerably less than oil from fresh seed.

[8]Creswell, C. F. and Bidwell: "Composition of Cotton Seed," U. S. Department of Agriculture Bulletin 948 (1921).

[9]Malowan, J.: "Chemical Changes in Cottonseed During Heat and Storage," Cotton Oil Press, Vol 5, No 4 (1921) pp 40-43.

[10]Rather, J. B.: "Biochemical Changes in Cottonseed in Storage," Arkansas Station Bulletin 125 (1916) pp 3-18.

EFFECTS OF HEATING ON THE QUALITY OF THE LINT

The data shown in Table II on the grade, staple, length, and character of cotton from the inside and surface of piles of cotton that heated, shows that the lint from the inside of the pile graded from one to four grades lower than that from the surface. The cotton had been cleaned and practically no trash was present in the lint when classed. The staple was classed shorter for the heated cotton in all cases, except one where it was the same.

The results of the fiber-breaking strength tests on cotton containing green, unopen bolls, which had been bulked and become heated, show that the fibers were materially weaker (Table II). The breaking strength in pounds per square inch of cellulose, of well-matured, hand-snapped cotton grown at the Lubbock Station and which did not heat when bulked, was 77,500 lb. In comparison, cotton also grown on the Lubbock Station farm which contained a high percentage of green, unopen bolls, and which heated badly when bulked, had a breaking strength of only 59,020 lb for cotton taken from the surface of the heated pile, and 57,595 lb for cotton taken from the inside of the pile. The well-matured cotton had 31 to 35 per cent greater breaking strength. This difference is highly significant since it is more than ten times the probable error.

Although the differences were not as great, somewhat similar results were obtained in analyzing samples taken from heated piles of cotton on farms in the vicinity of Lubbock (Table II). In every case, both at Lubbock and College Station, the breaking strength of the samples of cotton taken from the inside of the heated piles was lower than that taken from the surface.

Table I. Effects of Heating on Cotton Seed

Where sample was secured	Manner of harvesting	Location of sample taken from pile	Weight of 100 seed, in grams	Per cent of germination	Per cent of fat	Per cent of water
Agr. Eng. Farm, College Sta.	Stripped and piled	Surface	11.10	67	17.21	1.29
	Stripped and piled	Inside	10.40	4	15.34	1.28
Substation No 8, Lubbock	Stripped and piled	Surface	10.80	32		
	Stripped and piled	Inside	10.00	0	17.30	2.43
Perrin Bean Farm, Lubbock	Stripped and piled	Surface	11.10	64		
	Stripped and piled	Inside	8.40	0		
J. L. Snider Farm, Abernathy	Stripped and piled	Surface	9.22	55		
	Stripped and piled	Inside	9.95	0		
R. H. Bean Farm, Lubbock*	Stripped and windrowed	Surface	11.60	70		
	Stripped and windrowed	Inside	10.65	26		
Substation No 8, Lubbock*	Hand snapped and piled	Inside	10.70	76		

*Not heated.

Table II. Effects of Heating on the Quality of the Lint

Where sample was secured	Manner of harvesting	Location of sample taken from pile	Grade	Length, inches	Character	Breaking strength*
Agr. Eng. Farm, College Sta.	Stripped and piled	Surface	M	29/32	Good	75,100
	Stripped and piled	Inside	SM spot'd	29/32	Good	74,220
Substation No 8, Lubbock	Stripped and piled	Surface	SM	31/32	Good	59,020
	Stripped and piled	Inside	M yellow tin.	15/16	Weak, wasty	57,595
Perrin Bean Farm, Lubbock	Stripped and piled	Surface	SM spot'd	1-1/32	Good	75,940
	Stripped and piled	Inside	SLM tinged	15/16	Wasty	68,850
J. L. Snider Farm, Abernathy	Stripped and piled	Surface	SM spot'd	1	Good	66,760
	Stripped and piled	Inside	M spot'd	15/16	Good	65,600
R. H. Bean Farm, Lubbock**	Stripped and windrowed	Surface	SM spot'd	1-1/16	Good	
	Stripped and windrowed	Inside	SLM	1-1/32	Weak, wasty	65,340
Substation No 8, Lubbock**	Hand snapped and piled	Inside	M	31/32	Good	77,500

*Pounds per square inch of cellulose.
**Not heated.

The strength of the fiber is important in spinning, and the presence of weak fibers often results in an inferior quality of yarn. It is evident, therefore, from the results obtained in this study, that the spinning value of cotton which heats when bulked is decidedly lowered.

Summary and Conclusion

1 The piling in the field of cotton which had not fully matured, and which contained a high percentage of moisture in the form of green leaves and green unopen bolls, resulted in damage to the cotton by heating at both College Station and Lubbock, the highest temperature recorded on the inside of the piles being 133 deg, and 149 deg F, respectively.

2 Well-matured, hand-snapped cotton stored in the field in piles at Lubbock sweated slightly but apparently was not damaged by heating.

3 The germinating power of cotton seed was destroyed and the fat content lowered when the seed were subjected to excessive heating.

4 The heating of cotton in bulk lowered the grade of the lint one to four grades, and caused a loss of 31 to 35 per cent in the strength of the fiber.

5 The stage of maturity of the seed and lint, rather than the use of machinery in harvesting, was the main factor in causing the cotton to heat when bulked in large piles in the field.

6 In harvesting cotton mechanically, the cotton should be dry and practically free of green leaves and green unopen bolls, and the cotton should not be placed directly on damp ground for any great length of time prior to ginning, in order to avoid any damage to the cotton.

Light Traps in Insect Control[1]

By J. J. Davis[2]

ORDINARY lights have shown an attractiveness for many insects and in general the female individuals are not commonly attracted. Moveable lights have shown a noticeably greater attraction to females than stationary lights. Various devices, including section fans and electrically charged wires, have been developed to draw in and destroy the attracted insects. The relative value of ordinary lights seems to vary in relation to the situation.

There is also the possibility of utilizing light to produce conditions unfavorable for oviposition activity of certain insects. With the increasing cost of insecticide controls for certain insects, and the insecticide residue situation, there is a need for cheaper controls, and those which will not leave a residue.

Our own studies in an orchard at Orleans, Indiana, which were started this year, indicate that CX lamps attract several times as many codling moths as our best bait traps. As an index to the possible value of these lights, it may be stated that a few years ago we conducted a large-scale bait trap experiment and determined, as near as was possible, that the bait traps reduced the codling moth injury just about enough to pay for the cost and operation of the traps. Since the operation of light traps at present costs will amount to about five times the cost of bait traps, the results to date do not show a sufficient increased usefulness to pay for this cost and operation.

Recent studies by Dr. Lutz of the American Museum of Natural Science indicate that insects recognize and are attracted to the violet end of the spectrum and particularly to the ultra-violet rays. Our own experiments with variously colored bait pans show the same reaction of codling moths.

[1]Abstract of a contribution to a symposium, entitled "Agricultural Lighting," a feature of the program of the Rural Electric Division of the American Society of Agricultural Engineers at the 27th annual meeting of the Society, held at Purdue University, Lafayette, Indiana, June 1933.

[2]Purdue University Agricultural Experiment Station.

Agricultural Engineering Digest

A review of current literature on agricultural engineering by R. W. Trullinger, specialist in agricultural engineering, Office of Experiment Stations, U. S. Department of Agriculture. Requests for copies of publications abstracted should be addressed direct to the publisher.

Investigations on Water Movement in Permeable Earth Bodies [trans. title], O. Jahn (Wasserkr. u. Wasserwirtsch., 27 (1932), No. 16, pp 181-186, figs 9). This is a mechanical analysis of the movement of water through earth dams, the purpose of which is to provide a theory for the use of designing engineers.

Agricultural Engineering Investigations at the Pennsylvania Station, A. W. Clyde, C. O. Cromer, and R. U. Blasingame (Pennsylvania Sta. Bul. 279 (1932), pp 7, 8, fig 1). The progress report is presented of studies on the mechanical drying of hay, the development of a potato harvester, corn and potato production with mechanical power, and plowing and cultivating in stony ground.

American Tentative Standard Symbols for Heat and Thermodynamics (New York: Amer. Standards Assoc., Sect. Com-Sci. and Engin. Symb. and Abbrev., 1931, pp 7). This set of standard symbols was prepared by the Sectional Committee on Scientific and Engineering Symbols and Abbreviations and approved by the American Standards Association.

Flocculation, Dispersion, and Settling of Pigments in Relation to Adsorption, L. W. Ryan, W. D. Harkins, and D. M. Gans (Indus. and Engin. Chem., 24 (1932), No 11, pp 1288-1298. figs 9). The results of studies conducted at the University of Chicago are reported on the adsorption by pigments of various compounds, including metallic soaps, whose molecules contain a polar group, from solutions in a nonpolar liquid. Observations are also presented concerning the effects of the adsorption on flocculation, dispersion, and settling, and on the behavior of pigments in what may be termed solutions of infinite concentration—that is, in pure organic liquids.

The pigments used were titanium oxide, Titanox-B, Titanox-C, zinc oxide, and zinc sulphide. The pure organic liquids used were benzine, carbon tetrachloride, methanol, benzaldehyde, ethal acetate, oleic acid, and, for a part of the work, a great many other liquids. The metallic soaps used were precipitated and fused lead linoleate, precipitated and fused cobalt linoleate, precipitated aluminum stearate, precipitated titanium stearate, and in some experiments precipitated and fused lead tungate.

It was found that when suspended in a liquid containing a polar-nonpolar compound, pigments adsorb on their surfaces a monomolecular film of the polar-nonpolar compound. This adsorption has a marked influence on the flocculation, dispersion and settling of the pigments. Experiments on the settling of various pigments in dry pure organic liquids, and also in organic mixtures, show remarkable differences between the extent of the settling when (1) the pure liquid or solution consists entirely of nonpolar molecules, (2) either all, or a small fraction, of the molecules are of the polar-nonpolar type, and (3) water is also present.

In Case 1 the suspension is highly flocculated and the volume of the suspension is large—for example 16 cc per cubic centimeter of solid with a certain pigment. In Case 2 the flocculation disappears if enough polar-nonpolar molecules are present to give a monomolecular adsorbed film on the grains of powder, and the volume falls to about 5 cc. In Case 3 water added to (2) restores the flocculation and high volume of suspension characteristic of (1). The powders are dried in a high vacuum at temperatures of from 350 to 500 deg C, and the liquids are also dried with care. Experiments have been carried out with several white pigments in a great many organic liquids, and in solutions in benzene of metallic soaps and various organic compounds.

Stream Pollution by Irrigation Residues, C. S. Scofield (Indus. and Engin. Chem., 24 (1932), No. 11, pp 1223-1224). In a contribution from the U.S.D.A. Bureau of Plant Industry, observations from the Rio Grande Valley irrigation area in Texas, the Yuma Valley irrigation area in Arizona, and the Imperial Valley irrigation area in California, are briefly summarized, indicating that the normal operation of an irrigation project results in diminishing the volume of discharge of water without a corresponding decrease in the quantity of dissolved salts. In other words, the diversion of water from a stream for irrigation use operates normally to increase the concentration of salts in the stream water. From this it becomes apparent that in formulating a program for the most complete and effective utilization of the streams of desert regions, consideration should be given to the ultimate disposition of the salt burden.

It follows that the effective drainage of irrigated land, so designed and operated as to remove the residual soluble salts, is essential to the continued safe use of any water supply for irrigation. The character and quantity of the returned drainage water must be taken into account in any plans for the utilization of water from the lower part of a river in arid or semi-arid regions.

Preparation of Potable Water with "Carbosteril" [trans. title], M. Jaenicke (Gsndhts. Ingen., 55 (1932), No 49, pp 585-587, figs 2).—The results of tests of a method of preparing potable water in small quantities from ponds, streams, and swamps are briefly reported which involved chlorination, treatment with pulverized activated carbon, and removal of the carbon by filtration. It was possible by this means to produce water from such sources which was satisfactory physically, chemically, and bacteriologically. It was found that the adsorptive action of the activated carbon reduced the bacterial content of water appreciably, but that in order to insure absolute safety in this respect chlorination is necessary.

The Experimental Use of Artificial Light in Connection with the Growing of Cucumbers in Denmark, E. Stroud (Illum. Engin., 25 (1932), May, pp 123-125, figs 7).—The results of experiments to determine the most economical intensity of illumination for cucumbers are reported. The experiments involved the use of test fields in a line occupying a space about 35 ft long by 6 ft wide, two at one end using 500-W lamps in intensive prismatic reflectors, two at the other end using 750-W lamps in similar prismatic reflectors, and a center space without artificial light. The reflectors were covered so that all the light was emitted in a zone of 55 deg. The height of the units above the new plants was 1.325 m (4 ft 4 in), and the position of the lamp in the reflector was such that very little light was emitted outside the test fields.

It was found that not only did the light have no prejudicial effect on the plants, but that those illuminated had greener leaves and a greater leaf area. This, in conjunction with the longer (artificial) day, creates greater assimilation, and thus contributes to a more robust development of the root. The illumination therefore furnished a plant in quick and continuous development, which does not stagnate, and is more capable of resistance against diseases. A natural consequence is that it becomes no longer necessary to plant more seeds than precisely those required to furnish the quota of plants, which means a saving in seeds, space, and attention. The plants which were exposed to artificial light maintained throughout the lead they had originally gained.

The conclusion is drawn that the illumination yielded by the 500-W lamps was apparently sufficient. No very material advantage was shown in the behavior of plants in the area lighted by 750-W lamps.

The Application of Electric Light to Agriculture, F. E. Rowland (Illum. Engin., 25 (1932), May, pp 115-123, figs 15).—This is a summary of information relating to electric lighting for the general farm and for the poultry farm with special reference to conditions in England. Attention is drawn to experimental results obtained from various sources relating to the favorable influence of artificial illumination on egg production during the winter months.

The conclusion is drawn that the lighting load is comparatively so small that without the development of other uses of electricity rural electrification on an extensive scale would be impracticable. In addition to electric lighting, electric power and heating offer outstanding advantages not only on the farm but also in the farmhouse or dwelling.

Testing of the Fire Resistance of Building Materials and Structures, II, III [trans. title], R. Schlyter and C. Moller (Statens Provningsanst., Stockholm. Meddel. 57 (1932), pp [3]+71, figs 49; Eng. abs. pp 62-67).—Rules are presented for the fire-testing and classification of building materials, elements of structures, and the like, and the results of tests of partition walls of wood, protected by paneling reeding, and plastering on both sides, and unprotected, are reported. Six wall types were tested, including reeded and plastered wooden wall, partition wall of 5-cm planks unprotected, partition walls lined with asbestos and sheet metal, partition walls lined with asbestos-cement sheets, partition walls lined with Gyproc sheets, and partition walls lined with Kivron sheets.

The results showed that reeds and plaster, Gyproc, Kivron, and asbestos-cement sheets protect the wooden body of a wall against fire for about 15 to 20 min, the temperature of the experimental furnace being about 750 deg C after 15 min. The protective capacity of the thinner materials was generally limited to 5 min. It is concluded that partition walls should be faced on both sides.

Modern Farm Buildings, D. N. McHardy (London: Crosby Lockwood & Son, 1932, pp XII+227, figs 85).—The subject mat-

ter of this book falls into two sections, in the first of which the principles of construction are described in nontechnical language. The second section deals with the principles of design applicable to the various classes of buildings. Chapters are included on plan drawing; concrete; concrete construction; brickwork; roofing materials; carpentry and joinery; drainage; water supply; lighting; business considerations; cowsheds dairy buildings; housing dry cattle; stables, cart, and implement sheds; construction of piggeries; food supplies and crop storage; miscellaneous structures; modernizing old buildings; repairs and upkeep; form of contract agreement; and specification. An appendix contains cost and dimension estimates.

The Structure and Strength of Four North American Woods as Influenced by Range, Habitat, and Position in the Tree, J. E. Myer (N. Y. State Col. Forestry, Syracuse Univ., Tech. Pub. 31 (1930), pp 39).—This paper presents a study of the anatomical variations in the wood structure of four timber species, namely, eastern white pine, eastern hemlock, sugar maple, and white oak, and correlates the geographical distribution of the trees with variations in the structure and strength of the wood. The habitat factor was excluded except in the case of hemlock where material was collected from two different timber types in the Adirondacks.

It was found that the texture and strength of the wood of white pine, eastern hemlock, sugar maple, and white oak give scant evidence of being influenced by range, but quite definite relationships seem to hold with regard to position within the tree. Position in the tree does not appreciably affect the strength of pine wood, the wood at the butt being but slightly weaker than that at the 16-ft level. The strength values for hemlock hold quite constant for the first 16 ft and then decrease toward the top. Hemlock from the slope and spruce flat types gave no consistent differences in strength values.

In sugar maple there is no consistent relationship between range, texture, and strength. Position in the tree on the other hand appreciably influences texture and strength in compression. The compression strength parallel to the grain increases slightly in maple from the butt to the 16-ft level, above which it remains fairly constant.

Lengthwise in the tree the texture of white oak wood remains quite constant while density decreases from the butt to the top of the merchantable part. The compression strength parallel to the grain reaches its maximum at the 16-ft level on the bole and decreases toward both extremities.

Mole Drainage, J. H. Blackaby (Univ. Oxford. Inst. Research Agr. Engin., Tech. Notes Mech. Farming, No 1 (1932), pp 21, pls 5).—This pamphlet brings together such information as is available on mole drainage. A bibliography is included.

Mechanical Corn Pickers in Indiana, L. G. Hobson and R. H. Wileman (Indiana Sta. Bul 362 (1932), pp 23, figs 5).—Records of costs and performance on 187 mechanical corn pickers operated in nine counties of Indiana, secured in cooperation with the U.S.D.A. Bureau of Agricultural Economics, are summarized. The pickers were of the 1-row type, with and without a tank, and the 2-row type.

Machine husking, particularly with two-row pickers, was more economical on most of the farms in this study during the 1929 and 1930 seasons than was hand husking. During the 1931 season hand husking costs were so low that machine husking in most cases was not economical. Stalk pasture was of less value after a mechanical picker than after hand huskers. Two-row pickers left about one-third more corn in the field than did one-row pickers. Hand huskers left about one-third as much corn in the field as did mechanical pickers. Eighty-four per cent of the acreage picked by mechanical pickers was later pastured by livestock, and an additional 11 per cent was gone over and picked up by hand.

Mechanical picker owners gave considerable weight to such advantages as getting the corn out of the field early in better weather and in better condition, avoiding the inconvenience of having extra men to board and lodge during corn husking, and the fact that it was easier work to husk with a picker. Disadvantages frequently mentioned were trouble in using pickers in mud or soft ground, and when the ground and stalks were frozen, and difficulty in doing a good husking job when the corn was down very badly.

Farm Tractors, A. A. Stone (New York: John Wiley & Sons; London: Chapman & Hall, 1932, pp VII+492, figs 357).—Practical information is presented on the construction, operation, and repair of farm tractors.

Continuous Frames of Reinforced Concrete, H. Cross and N. D. Morgan (New York: John Wiley & Sons; London: Chapman & Hall, 1932, pp X+343, pl 1, figs 299).—This book picturizes deformations in structural frames and emphasizes the importance of this process and the elementary nature of geometry involved. It contains chapters on statics of deflected structures; geometry of deflected structures; moment distribution; haunched beams; continuous girders—maximum moments, shears, and reactions; rigid frames; influence lines; and right arches of reinforced concrete.

Graphic Statics, S. Fairman and C. S. Cutshall (New York and London: McGraw-Hill Book Co., 1932, pp VIII+145, figs 136).—The fundamental principles of graphic statics are elucidated in this book and their relation shown to trusses and bents, cranes, derricks, dredges, and other machines. An appendix presents the graphical solution for certain special problems, including centroid and moment of inertia of an area and bending moments in different planes.

Recent Advances in Physics (Non-Atomic), F. H. Newman (London: J. & A. Churchill, 1932, pp IX+378, figs 51).—An attempt is made in this book to present some of the chief advances in physics, mainly non-atomic, that have been made during the past few years. Chapters are included on the wave-like character of matter, statistical mechanics, the general properties of matter, acoustics, low temperatures, electromagnetic radiations, magetism, and electricity.

Dairy Manufacturing Machinery, B. Lichtenberger (Lehrbuch der Milchwirtschaftlichen Maschinenkunde. Hildesheim: Molk. -Ztg., 1932, pp 370, pls 31, figs 185).—This book, which is written from the German viewpoint, brings together a large amount of information relating to machinery and equipment used in dairying and in dairy manufacture and discusses the design and development of such equipment for specific purposes.

Stresses in Simple Structures, L. C. Urquhart and C. E. O'Rourke (New York and London: McGraw-Hill Book Co., 1932, 2. ed., pp IX+339, figs 260).—This is the second revised edition of this book. It contains chapters on definitions and principles, fundamental principles of graphic statics, roof trusses, stresses in framed bents, bridge trusses under dead load, stresses in trusses due to uniform live loads, concentrated moving loads on beams and girders, concentrated moving loads on trusses, lateral forces on bridge trusses, influence lines, three-hinged arches, and deflection.

Greenhouses and Hotbeds, F. Bohmig (Gewachshauser und Fruhbeete. Berlin: Paul Parey, 1932, pp VIII+193, figs 169).—This book gives both practical and technical information on the design, construction, and use of greenhouses and hotbeds and describes equipment such as heating plants and facilities for watering. It is based entirely on German practice and experience.

Rural Fire Waste in Iowa, 1930-31, H. Giese and E. D. Anderson (Iowa Sta. Bul. 296 (1932), pp 221-258, figs 16).—The results of an investigation to determine methods of reducing rural fire waste in Iowa are reported in this bulletin.

The rural fire loss in Iowa for 1931 was less than for 1930, although the trend for the state as a whole has been upward since 1928. Country losses were largely total. While the number of fires in the country about equaled that in towns, the property damage was 88 per cent greater. Eight per cent of the country fires were group fires, causing only about 14 per cent of the total loss. This is taken to indicate that a program depending largely upon the saving of buildings in the farmstead other than the one in which the fire originates does not offer a very promising means of reducing fire loss. The greatest losses were to dwellings and barns, the ratio being 2 : 1.

Of the known causes, sparks on roofs and defective flues were the largest items in dwelling fires, while spontaneous combustion of hay and straw and lightning on nonrodded buildings were responsible for the major amount of barn losses. The greatest losses occurred during the first quarter of the year, and fire losses were rather uniformly distributed throughout the 24 hours of the day. Country losses were almost equally distributed between owner and tenant occupied buildings and proportional to the actual distribution of tenancy.

Research in Soil Erosion at the North Carolina Station, J. M. Snyder and F. O. Bartel (North Carolina Sta. Rpt. 1931, pp 47-52).—A description is given of the experimental work in soil erosion control being conducted at the station in cooperation with the U.S.D.A. Bureau of Agricultural Engineering.

An Experimental Investigation of the Friction of Screw Threads, C. W. Ham and D. G. Ryan (Ill. Univ., Engin. Expt. Sta. Bul. 247 (1932), pp 62, figs 26).—The results of an investigation are reported the purpose of which was to determine values for coefficients of friction applicable to the present-day operation of power screws. The conclusions are in considerable detail and are useful in connection with the design of power equipment for shop purposes. An appendix deals with the friction of collar thrust bearings.

The Structure of Clay and Its Importance in Foundation Engineering, A. Casagrande (Jour. Boston Soc. Civ. Engin., 19 (1932), No 4, pp 168-221, figs 31).—This is a contribution from the U.S.D.A. Bureau of Public Roads in which an attempt is made to illustrate the fact that in the building of foundations on clay it is important that the natural structure of the clay be not disturbed and that a definite bearing value of clay does not exist.

The Artificial Lighting of Poultry Houses, R. T. Parkhurst (Scot. Jour. Agr., 15 (1932), No 4, pp 422-426).—Studies conducted at the National Institute of Poultry Husbandry in Scot-

land are reported in which different lighting arrangements were tested.

It was found that the morning and evening system of lighting gave the best results. It increased the production and income, provided absolute regularity from autumn to spring, and divided the discharge of the batteries between night and morning, thereby lightening the load on the generator. The all-night lights gave disappointing results, although in the long run they were superior to all others for hens.

Electric Tillage (Impl. and Mach. Rev., 58 (1932), No 692, pp 631-633, figs 2).—A brief report is presented of field tests of a new electric tractor. The tractor consists primarily of an angle iron frame supported mainly by two broad drum wheels, inside each of which is attached a powerful motor, which is suspended from the axle and drives the wheel. A smaller stub frame is offset to the main frame and forms the mounting for a winding drum to carry the cable. A multiple-furrow plow is attached to the front and rear, making the outfit a 1-way plowing unit that avoids all open furrows.

Power is fed from the three-phase wiring system by attaching a trolley pole to the four wires. The pole is fitted with runners to permit it to slide along rapidly. The current is subject to the operation of a main switch on the tractor and is further controlled for individual duties by other switches.

Interpretation of Laboratory Findings in Rural Spring Water Supplies, E. K. Kline and N. M. Fuller (Amer. Jour. Pub. Health, 22 (1932) No 7, pp 691-699, figs 5).—In a contribution from the Cattaraugus County (N. Y.) Department of Health, results of a study of the influence of salamanders on rural water supplies are reported.

It was found that salamanders live in large numbers deep within the shale along the underground streams. At certain seasons they come to the surface and travel a distance of at least 65 ft overland where they feed on insects, worms, fly larvae, and similar food. Should these be infected with B. coli through improper protection of the area from direct fecal pollution or surface drainage the salamanders become infected. They then return to the depths and throw off B. coli for a considerable time. Laboratory tests on such a water supply would suggest condemnation even though the supply was otherwise unpolluted.

Prevention and Control of Farm Fires, edited by A. Secor (Chicago: [I. D. Goss], 1932, pp XII+13—167, figs 12).—This is a handbook on the causes of fires and on the best methods of safeguarding against loss of life and property through them. Special attention is drawn to the fact that good construction is an aid to the prevention and control of farm fires. Other fire-protection methods are discussed.

Chemical Character of Surface Waters of Virginia, W. D. Collins, E. W. Lohr, K. T. Williams, H. S. Haller, and O. C. Kenworthy (Va. State Comn. Conserv. and Devlpmt., Div. Water Resources and Power Bul. 3 (1932), pp [7]+148, pl 1, figs 7).—This report, which was prepared in cooperation with the U. S. Geological Survey, presents data on the chemical composition of rivers and streams in Virginia. The main constituents of the water are calcium, magnesium, and bicarbonate. The general softness of the waters of the Coastal Plain and of the Piedmont is evident.

When to Lay Wood Floors Over Concrete Subfloors, M. E. Dunlap (Engin. and Contr., 71 (1932), No 12, pp 275, 276, figs 3).—Methods and apparatus developed by the U.S.D.A. Forest Service for determining the proper moisture conditions which will permit the laying of wood floors over concrete subfloors are briefly described and illustrated.

Spectroscopic Studies of Engine Combustion, L. Withrow and G. M. Rassweiler (Indus. and Engin. Chem., 23 (1931), No 7, pp 769-776, figs 5).—This paper describes a preliminary spectrographic study of the physical and chemical processes which take place in a gasoline engine.

Separate spectrographic studies made of the flame fronts and afterglows of explosions produced with several fuels in a gasoline engine indicated that the reactions accompanying the afterglows are different from those taking place in the flame fronts. The visible afterglow spectrum is emitted by the same molecules which give off light during a reaction between carbon monoxide and oxygen, while visible light from the flame fronts of hydrocarbon fuels in nonknocking explosions comes largely from CH and C_2 molecules. The gasoline flame fronts in the detonating zone during knocking explosions show CH and C_2 bands only faintly, but flame fronts outside of the detonating zone exhibit both sets of bands with intensities comparable with nonknocking explosions. Addition of lead tetraethyl to the gasoline removes the knock and reestablishes the CH and C_2 bands in the light from the detonating zone. Lead is present in the flame fronts as atomic lead and molecular lead monoxide.

Electric Service for the Iowa Farm.—Report No 7, Operating Cost of the Individual Farm Electric Plant, F. D. Paine and F. J. Zink (Iowa State Col. Off. Pub., 31 (1932), No 1, pp 15, fig 1).—This is a continuation of the progress report on the rural electrification project in Iowa. Data obtained on the cost of operation of individual farm electric plants are analyzed and discussed.

It was found that at present-day prices of individual electric plants and fuel, electricity can be generated by such plants at a cost of approximately 50c per kilowatt-hour when the amount generated is about 240 kwh per year. The cost of electricity from such a plant decreases as the amount generated per unit of time increases and varies from $1 when 100 kwh are generated to less than 30c when 1,000 kwh are generated per year.

It was found that the monthly use of electricity is greatest in December and least in June, varying from an average of 12.5 to 29.6 kwh per month with the storage-battery plants.

Soil Action Under Load Shown by Test, D. P. Krynine Engin. News-Rec., 109 (1932), No 26, pp 782-784, figs 3).—The results of studies at Yale University are briefly reported in which the movement of soil under a test load was disclosed by excavating a vertical cut under the loaded area and by observing the soil movement and moisture condition.

Production of Insulating Board from Cornstalks, C. E. Hartford (Indus. and Engin. Chem., 22 (1930), No 12, pp 1280-1284, figs 5).—The manufacture of insulating board from cornstalks on a commercial scale is described and illustrated. Heat conductance tests made by the flat plate method gave heat conductivity coefficients varying from 0.32 and 0.345. Data also are briefly reported from tests of moisture absorption and tensile and cross-breaking strengths.

Progress Toward a Uniform Method of Measuring Detonation, T. A. Boyd (Indus. and Engin. Chem., 22 (1930), No 12, pp 1301, 1302).—This is a synopsis of a report of the subcommittee on methods of measuring detonation of the American Petroleum Institute Cooperative Fuel Research Steering Committee.

Freezing and Flow Points for Glycerol, Prestone, Denatured Alcohol, and Methanol, J. C. Olsen, A. S. Brunjes, and J. W. Olsen (Indus. and Engin. Chem., 22 (1930), No 12, pp 1315-1317, figs 5).—In a contribution from the Polytechnic Institute of Brooklyn, N. Y., data are presented on these antifreeze compounds.

It was found that the flow point is only a few degrees lower than the freezing point for temperatures down to —25 deg C for all the materials except glycerol. Below —25 deg the difference tends to increase to about 7 deg. Commercial ethylene glycol in solutions of from 10 to 60 per cent by weight and 9.1 to 57.48 per cent by volume showed freezing points varying from 26.1 to —50.8 deg F and flow points varying from 24.3 to 63.4 deg F. Synthetic methanol in solutions of from 10 to 40 per cent by weight and 12.24 to 45.56 per cent by volume showed freezing points varying from 19.8 to —43.6 deg F and flow points varying from 16.7 to —57.1 deg F. Denatured alcohol in solutions of from 10 to 60 per cent by weight and 11.9 to 64.66 per cent by volume showed freezing points varying from 24.26 to —43.6 deg F and flow points varying from 21.2 to —52.5 deg F.

Glycerol appears to be a considerably less efficient antifreeze than the other three materials.

The Effect of Jacket and Valve Temperatures on Knock Ratings of Motor Fuels, F. H. Garner and E. M. Dodds (Engineering [London], 134 (1932), Nos 3469, pp 45-47, figs 7; 3470, pp 60-62, figs 8).—Studies are reported in which an engine with solid valves, one with liquid-cooled valves, and an air-cooled engine were used with a fuel of poor antiknock value (octane number of 50) as a reference fuel. Additions of definite proportions of benzol were made to this fuel, and the amount of lead tetraethyl required to be added to the reference fuel to give the same antiknock value was then determined on each of the three engines.

With the solid-valve engine the lead tetraethyl-benzol equivalents were relatively little influenced by the variation of the temperature. The difference in results with jacket temperatures of 100 and 150 deg C was only slightly greater than the experimental error.

With the engine with liquid-cooled valves the differences were much more marked. At 50 deg a mixture of 75 parts of benzol and 100 parts of gasoline required about one-third as much lead again in the standard gasoline to give a fuel of equal antiknock value than did a similarly proportioned benzol-gasoline blend under the same conditions in the first engine.

With the air-cooled engine the amount of lead tetraethyl required to equal a benzol mixture in antiknock value was, in general, less than that of either of the other two engines.

For the three engines at 100 deg the relation between benzol and lead tetraethyl was approximately linear, the equivalents being expressed by the relationship that the addition of 10 per cent benzol is equal to 0.50 cc of lead tetraethyl per imperial gallon. With the more efficiently cooled engines it was found that more lead tetraethyl is required at the higher concentrations of benzol.

In every case, with higher cylinder-head temperatures, lead became relatively more effective as an antiknock agent. This was shown to a remarkable extent with the air-cooled engine where very high temperatures were obtained.

The results obtained in the engine with the solid valves

showed that the effect of temperature on the knock rating of fuels containing either benzol or lead tetraethyl is much less marked than with the other two engines.

In the course of these experiments a series of five fuels was employed with octane numbers ranging from 55 to 75. These represented typical spirits sold on the British market, the 75-octane number fuel being a highly cracked spirit. A comparison was made between these various spirits and the blend of reference fuel with either lead tetraethyl or benzol.

With solid valves all the motor spirits required slightly lower percentages of both lead tetraethyl and benzol in the reference fuel at the higher temperatures than at the lower temperatures, i.e., the antiknock value expressed either as lead tetraethyl or benzol in the reference fuel is lower at the higher temperatures. The quantity of lead tetraethyl in the reference fuel required to equal the various motor spirits was much lower at the higher temperatures, with one exception. Much higher percentages of benzol in the reference fuel were, however, required at the higher temperatures than at the lower temperatures. The cracked fuel required proportionately less benzol at the higher temperatures than the other spirits.

These results are considered to emphasize the fact that in order to obtain consistent antiknock values of motor fuels, it is essential that the same standard test engine be used and the conditions of operation carefully standardized.

It was found further that in the solid-valve engine, with fuels of similar antiknock tendencies, the temperature of the exhaust valve varies to a considerable extent. Similarly, the temperature of the exhaust valve varies widely according to the conditions of operation and extent of valve guide wear. Repeat experiments on the same fuels, on different days under different conditions, showed wide variation in temperatures.

The Ignition and Combustion Process in the Coal Dust Engine, W. Wentzel, trans. by K. Goggin (Forsch. Geb. Ingenieurw., Forschungsheft 343 (1931), pp [4]+23, figs 21; trans. in Fuel, 11 (1932), Nos 5, pp 177-196, figs 19; 6, pp 222-228, figs 2).—An experimental apparatus is described for determining the time required for ignition and combustion of coal dust which is injected by means of compressed air into compressed heated air. With this apparatus the effects of temperature and density of the combustion air, injection pressure, particle size, and kind of coal on the ignition lag and combustion time were investigated.

The ignition lag was found to be independent of excess air and almost independent of injection pressure. It increased with decreasing temperature of the combustion air. The ignition limit was reached at a definite temperature, and the ignition lag and the position of the ignition limit were found to depend on the density of the combustion air. The size of the smallest particles present determined the ignition lag, and if no very fine particles were present in the dust the ignition lag increased rapidly. The richer the coal in gas the lower was ignition limit. For temperatures of combustion air near the ignition limit, the values for ignition lag in the case of prepared dust lay between 0.01 and 0.03 second.

Combustion time was found to be independent of the temperature of the combustion air so long as this was not too near the ignition limit. On the other hand there was a strong dependency on excess air and on injection pressure. The density of the combustion air had no effect on combustion. Combustion time was also greatly dependent on the grain size composition of the dust. With sufficient excess air and good injection the values for combustion time of prepared dust lay between 0.15 and 0.35 sec, according to the grain size composition and kind of coal. These results are discussed in their application to the operation of the coal dust engine.

Agricultural Engineering Investigations at the Arkansas Station, D. G. Carter, J. B. Woods, and R. M. Smith (Arkansas Sta. Bul. 280 (1932), pp 34-36).—The progress results of studies on cotton machinery, effect of deep tillage on soil moisture, control of stem rot of rice by burning, preservation of posts, water cooling of milk and cream, influence of poultry housing factors on egg production, and kitchen plans and storage equipment are briefly reported.

Agricultural Engineering Investigations at the Illinois Station (Illinois Sta. Rpt. 1932, pp 175-188, figs 2).—The progress results of investigations on rural use of electricity, farm sewage disposal, tractor lubrication, tractor repairs, plowing for corn borer control, terracing, improved harvesting methods, crop drying, stationary spray plants, and hog and poultry houses are briefly reported.

Agricultural Engineering Investigations at the Colorado Station, R. L. Parshall, E. B. House, and F. E. Goetz (Colorado Sta. Rpt. 1932, pp 54-57, 60-62).—The progress results of irrigation investigations including measurement of water, pumping, and evaporation, and of investigations on hair cracks in concrete, poultry houses, and sugar beet machinery are briefly reported. The sugar beet machinery investigations and most of the irrigation investigations are being conducted in cooperation with the U.S.D.A. Bureau of Agricultural Engineering.

Agricultural Engineering Investigations at the Michigan Station (Michigan Sta. Bien. Rpt. 1931-32, pp 5-7).—The progress results of investigations on plowshare treatment, combine harvesters, electric heat in poultry houses, dairy structures, whitewash and paints, canvas hose irrigation, and use of fractional horsepower motors are briefly reported.

Agricultural Engineering Investigations at the Oklahoma Station, N. E. Winters, O. E. Goff, C. Roberts, and L. E. Hazen (Oklahoma Sta. [Bien.] Rpt. 1931-32, pp 7-13, 140, 141, 275-277, figs 3).—The progress results of investigations on soil and moisture conservation, the use of insulating board for stabilizing temperatures in poultry houses, and the use of terraces for the control of soil washing are briefly reported.

Electricity on the Poultry Farm, L. J. Smith and H. L. Garver (Washington Col. Sta. Pop. Bul. 148 (1932), pp 71, figs 30).—This is the ninth of a series of bulletins dealing with the use of electricity on the farm and prepared by the station and the Washington Committee on the Relation of Electricity to Agriculture. Its purpose is to present in useful form such practical information on the uses of electrical energy on the poultry farm as have been made available by the different experiment stations and others. In essence, therefore, it is a summary of data, papers, and reports from various sources dealing with poultry house lighting, lighting schedules, dimming devices, types of controls, the use of ultra-violet light, candling eggs, electricity for feed appliances, incubation, electric brooding, types of brooders, electric brooding suggestions, control of cannibalism, water heating, a poultry semiscalder, ventilation, refrigeration, wiring, yard lighting, and burglar alarms.

Methods of Supplying Electric Heat to Hotbeds, T. M. Currence (Minnesota Sta. Bul. 280 (1932), pp 19, figs 11).—This bulletin outlines results of an experiment with four electrical heating combinations for hotbeds and suggests the possibility of combining a heating method with one for lighting.

The comparison of the four methods of heating hotbeds electrically indicated that any of them will provide sufficient heat even in very cold weather. The use of current, however, is markedly increased by lower outside temperatures. Radish and lettuce plants grown during the period from February 8 to March 20 attained the largest size in sections that were supplied with artificial light. The current used was greater than that used in the other two. The current required to raise the air temperature of the frames a certain number of degrees above the outside temperature was less in the two frames that had no electric lights. This is not an entirely satisfactory comparison, because light may often be the limiting factor in plant growth. The spring experiment covered the period between March 21 and April 30. The amount of current required for germination of the four crops planted was less in the frames where heat was applied in the soil.

The growth of the plants was best in the sections equipped with lights. The lighted beds gave the smallest current requirement per unit of growth figures for all crops except peppers, which responded about the same to all treatments.

Three growers of vegetable plants furnished certain observations which show chiefly that heating with cable is satisfactory and not expensive. Costs from the three show an average of approximately 95c per sash for 31 days.

Wind-Resistant Construction for Farm Buildings, M. C. Betts and W. Ashby (U. S. Dept. Agr. Leaflet 87 (1932), pp 6, figs 6).—Practical information is given on foundation construction, wall bracing, floor construction, and roof anchorage.

Agricultural Engineering Investigations at the Arizona Station, G. E. P. Smith (Arizona Sta. Rept. 1932, pp 64-71, fig 1).—The progress results of studies on ground water supplies and movement, pumping machinery, evaporation and duty of water, and citrus irrigation are briefly reported.

Agricultural Engineering Investigations at the Montana Station, Montana Sta. Rpt. 1931, pp 34-36, figs 2).—The progress results of investigations on tractor loading, carburetor adjustment, and speed and draft are briefly reported.

Electric Soil and Hotbed Heating, H. Beresford (Idaho Sta. Circ. 68 (1932), pp 26, figs 19).—The results of studies conducted by the station, in cooperation with the Idaho Committee on the Relation of Electricity to Agriculture, on electric soil and hotbed heating are briefly reported and deductions therefrom presented in the form of practical information and instructions.

It has been found that the advantages of heat obtained from an electrical source are that the installation may be made permanent and that temperature may be maintained and regulated automatically to the needs of any particular plant. These features permit the forced growth and early maturity of spring vegetables suited to hotbed planting.

The fact that electrically heated hotbeds are permanent, a feature which saves considerable labor when compared with the manure-type beds, makes the installation and operating cost of the electric beds compare favorably with any other source of heat. It is also possible with electric heat to control the air and soil temperature ratio. The satisfactory growth of plants and the assurance that beds are protected from freezing tem-

peratures are also important features of electrically heated hotbeds.

It was found possible to heat soil in garden plats not protected by hotbed frames in order to force the growth of flowers or garden crops. The saving in energy costs made possible by the protection of the hotbed frames, as well as the more rapid growth of the plants, indicated that electric soil heating is more economical when installed in the hotbed frames.

A 6-by-6-ft frame is the smallest size that can be adapted readily to the soil-heating wire because it is necessary to use about 60 ft of wire on the standard 110-v circuit. This size of bed requires two standard 3-by-6-ft sash, each of which is supplied with 30 ft of wire, having a capacity of 200 w per sash, or a total of 400 w for the 6-by-6-ft frame.

Principles of Reinforced Concrete Construction, F. E. Turneaure and E. R. Maurer (New York: John Wiley & Sons; London: Chapman & Hall, 1932, 4. ed., rev., pp XI+461, figs 220).—This is the fourth revised edition of this book in which due consideration is given to the latest experiments and developments in methods of calculation and design. Some of the more important changes include revised formulas and diagrams for the design of beams, including circular sections subjected to bending and compression; adaptation of diagrams to the use of any desired value of **n**; discussion of recent tests on beams and columns; amplification of material on flat slabs, including detailed treatment of footings; more adequate development of the analysis of continuous beams; application of the slope-deflection method to building frames, including haunched beams with general results for typical cases; application of method of moment distribution to continuous girders and frames; complete detailed analysis of the arch with methods of arriving at tentative designs; torsional stresses in beams; and effect of shrinkage and plastic flow on stresses in beams, columns, and arches.

Design Factors Affecting the Strength and Rigidity of Wooden Crates, G. E. Heck (U. S. Dept. Agr. Circ. 236 (1932), pp 27, figs 24).—The purpose of this publication is to show the effect of various design details on the strength and rigidity of wooden crates. In this connection the results are presented of tests made in cooperation with the University of Wisconsin on 550 crates of ponderosa pine, western hemlock, and Sitka spruce.

It was found that the point of failure in diagonally braced crates made of lumber free from injurious defects is usually at the fastening of the diagonals to the edge members. The forces in the various crate faces tending to cause the splitting of the edge members to which diagonal braces are nailed are approximately proportional to the lengths of the edge members to which the braces are not nailed. A long edge member will fail more readily by splitting at the fastening of the diagonal braces than a short edge member when the braces are nailed to the narrow faces of the edge members.

Increase in width or thickness of all the crate members generally results in a substantial increase in strength, provided the nailing is in accordance with the recommended nailing schedule. The best practice is to use rectangular crate members as nearly square as practicable. Crates of the sizes tested, having 6 diagonal braces one-half the thickness of the edge members, are nearly as strong and rigid as similar crates having braces the same thickness as the edge members. The difference in strength between crates having the long edge members of the smallest faces placed outside the short edge members and crates having the short edge members of the smallest faces placed outside the long edge members is so small that the controlling factor should be convenience and protection of the faces of the commodity rather than increased strength of the crate.

Whether diagonal braces are in tension or compression under load makes no difference in the ultimate strength of a crate, provided the braces are thick enough to develop the full strength of the nailed joint without bending. Under normal conditions this would be at a ratio of 60 : 1. The strength and rigidity of a crate increases with each diagonal brace added, the maximum increase occurring with the addition of the sixth brace. Unless the commodity is known to be able to take torsional stress or is so suspended in the crate that it will not twist with distortion of the crate, all faces of the crate should be braced. Crates having 12 diagonal braces (two crossed in each face) one-half the thickness of the edge members showed approximately one and one-half times the strength of crates with 6 diagonal braces of the same thickness as the edge members nailed to the edges of the edge members. In crates with 2 braces one-half the thickness of the edge members crossed in each face, nailing the braces at their intersection resulted in slightly increasing the strength of the crates. In crates having one diagonal brace in each face, nailing reinforcing blocks to the edge members at the ends of all 6 diagonals resulted in an average increase in strength of approximately two-thirds, as compared with the strength of unreinforced crates. For crates with 6 diagonal braces, nailing the braces to the wide faces of the edge members and clinching the nails resulted in the crates having more than twice the strength of crates in which the braces were nailed to the edges of the edge members.

American Cypress and Its Uses (U. S. Dept. Com., Bur. Foreign and Dom. Com., Trade Prom. Ser. 141 (1932), pp IV+28, figs 18).—This pamphlet, prepared jointly by the U.S.D.C. Lumber Division and the National Committee on Wood Utilization, presents general practical information on properties and uses of American cypress as lumber.

Shear Tests of Reinforced Brick Masonry Beams, D. E. Parsons, A. H. Stang, and J. W. McBurney ([U.S.] Bur. Standards Jour. Res., 9 (1932), No 6, pp 749-768, figs 7).—Eighteen beams of reinforced brick masonry were tested to determine their resistance to failure by diagonal tension. The beams were 14 ft long and about 1 ft square in cross section. Beams of three different types of construction were tested, an equal number with each of two kinds of brick. A 1 : 3 portland cement mortar, with addition of lime equal to 15 per cent of the volume of the cement, was used in all beams. Each beam contained six 0.5-in square steel bars as tensile reinforcement. Tensile and shear tests of the bond between mortar and brick and pull-out tests of steel bars embedded in brick masonry were made to supplement the data from the beam tests.

Positions of the neutral axes in the beams varied with the kind of brick, arrangement of bricks in the beams, and loads. The ratio of depth to neutral axis to depth of the tensile reinforcement increased with an increase in the number and total thickness of mortar joints in the masonry. The position of the neutral axis corresponded to that calculated by means of the design formulas applying to beams of reinforced concrete, with an assumed modulus of elasticity of the masonry equal to from 50 to 70 per cent of that of the masonry piers.

The failures of all beams were accompanied by cracks near the ends of the beams, between a support, and the nearer load. The cracks were evidence of failures of diagonal tension.

Maximum shearing stresses for the different types of beams ranged from 65 to 159 lb per square inch. Resistance to diagonal tension increased with an increase in the proportion of bricks laid with staggered joints. Shearing strengths of the beams were in the same order as shearing and tensile bond strengths of small masonry specimens.

With the relatively absorbent bricks used, tensile and shearing strengths of the masonry were much greater when bricks were wetted before laying than when laid dry.

Bond strengths as determined by pull-out tests of 0.5-in square deformed bars embedded about 8 in in brick masonry ranged from 870 to 950 lb per square inch. Differences in the kinds of brick and curing conditions did not cause significant changes in bond strength.

Higher Efficiency in Domestic Heating, H. J. Dana and H. H. Langdon (Northwest Sci., 6 (1932), No 3, pp 90-97, figs 2).—Studies conducted at the Washington State College are reported briefly. These showed that hand firing in the usual type of household furnace yields a very low overall fuel efficiency of from 30 to 40 per cent. The use of a stoker will improve this efficiency between 10 and 20 per cent. Replacing the conventional furnace with an improved design of furnace having better combustion space and more adequate heat exchanger gave an efficiency of 82.5 per cent, using less than half the coal to heat the same house at 33.7 per cent. The addition of a hot air economizer to a conventional hot water, stoker-operated furnace, yielded an overall average efficiency of 87.2 per cent, the additional heat being extracted from the flue gases.

High efficiency, namely, 90.2 per cent, was obtained during the stoker operating period, but this was reduced by the long coasting period to an average of 87.2 per cent for the entire cycle, showing the desirability either of burning the fuel as fast as it is introduced, or of maintaining continuous stoker operation with varying rate of combustion.

Artificial Drying of Hay in Russia [trans. title], M. Evreinov (Electrif. Selsk. Khoz., 1 (1931), No 7, pp 30-44, figs 19).—The results of experiments on the artificial drying of hay by hot air blast through open stacks or stacks inclosed in tubes are reported. The hot air blast is gravity cleaned and has a temperature of from 90 to 100 deg C. The data are mostly of a service character but indicate the probability that the process is sound and economical.

Heating the Soil by Electricity [trans. title], A. Tsekulina (Elektrif. Selsk. Khoz., 1 (1931), No 7, pp 46-51, figs 8).—The methods and equipment used in the electrical heating of soil under 2,200 coldframes for the germination of cotton plants are described and illustrated. The electrical current was conducted through a set of iron wires 12 to 15 cm below the soil which was supported on a wooden grill. Data on installation and operation are given, it being pointed out that the open iron wires are a source of danger.

Electrification of the Poultry Industry [trans. title], G. Shekhalevich (Elektrif. Selsk. Khoz., 1 (1931), No 7, pp 52-57, figs 4).—Data are presented on the installation of electric light in poultry and brooder houses, on the use of ultra-violet ray treatment of poultry, electrical ventilation of poultry houses, electrical incubation, and electrical heating.

Spreading of Liquids on Solid Surfaces: The Anomalous Behavior of Fatty Oils and Fatty Acids with Experiments Leading to a Tentative Explanation, R. Bulkley and G. H. S. Snyder

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RAYMOND OLNEY, Editor

R. A. PALMER, Associate Editor

Can Distribution Be Engineered?

A PROMINENT advisor of the national administration recently aroused criticism by telling a merchandising trade association that there are too many people engaged in the distribution of goods. It evidently was a tender spot. It has long been a sore spot in our economic organism. Not only is the price the consumer pays for most products in shocking disparity with the price which the producer gets, but the tendency over the years has been for the disparity to increase.

Engineers have been confined largely to the field of production, and they have achieved notable economies in production costs. Gratified as they may be at their personal success within the limits of their jobs, they must be disheartened at seeing all or most of their economies cancelled by increases in distribution costs.

Some of this added cost of transportation and merchandising is inherent in the centralization of mass manufacture, and the remedy may be found in decentralization. If so, manufacturing enterprise, under a system of free and fair competition, may be expected to find it out and apply it. Though industry has shown itself competent in manufacture, it has contributed little toward more efficient distribution.

Contrary to some of the beliefs about "middlemen," repeated studies reveal no excessive profits anywhere along the line. Few tradesmen get rich, and many go bankrupt. Detailed figures prove what common sense suggests, namely, that the seemingly unconscionable margins between producer and consumer prices are frittered away in a myriad movements, handlings, wastes, and losses. It is just inefficiency.

Engineers have had such shining success in correcting inefficiency in production that the question naturally arises: Why not let them try their hand at distribution? Possibly they could work out something comparable in efficiency to mass manufacture and line assembly. Until something is done to lower the hurdle between producer and consumer, neither of these parties can get the full benefit of the economies the engineer has achieved in production.

This is not a job for agricultural engineers alone, or even in special measure. But no other branch of engineering represents so broadly both production and consumption. In no other great industry are the engineer's clients so helpless in passing costs along to the consumer. Agriculture is the prime example of distribution costs being borne by the producer. The farmer does not get Pittsburgh plus, but Chicago minus. So, even though the subject matter may not fall mainly in his province, the agricultural engineer has incentive enough for taking the lead in steps toward engineered distribution.

Don't Repair; Rebuild

SOME, at least, of the real estate and insurance men, the latter presumably speaking from both the investment and inspection angles, say that we have a plenty of "big stuff"—office, factory, hotel, and apartment buildings. They say that small homes will be the backbone of the next building era, but that new building should for a time be overshadowed by a vast amount of repairing, remodelling, and modernizing for which need has accrued through years of neglect.

If this is true from an obviously urban viewpoint, it is even more true of farm buildings. Many farm buildings have depreciated to a point where repair will be so extensive as to open up the question of replacement or remodelling for greater comfort or efficiency. The farm structures men in the colleges and elsewhere are better than ever prepared to offer plans and a degree of supervision. It will be a shrewd move for the building materials interests to urge farm builders to consult these structures engineers. The materials people will get more business, and the farmers will get better buildings.

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(Jour. Amer. Chem. Soc., 55 (1933), No 1, pp 194-208, figs 8).—Several lines of experimental evidence are described in support of the view that the interfacial tension between metals and petroleum oils is substantially greater than between metals and fatty oils or between metals and fatty acids. The energy requirements for spreading on solids being the same as for spreading on liquids, the fatty oils and fatty acids should spread more readily than mineral oils on metal surfaces. Experimentally, fatty oils and fatty acids spread little or not at all while mineral oils spread apparently without limit. The nonspreading of the fatty liquids must therefore be regarded as anomalous.

The higher fatty acids do not wet polished metal surfaces in the ordinary sense, but roll about freely. They deposit an adsorbed film on the surface which reduces the surface energy to a low value. Thin layers of mineral oil containing fatty acids rupture spontaneously on metal surfaces. The explanation is the same as when a similar phenomenon occurs on water, namely, the formation of an underlying film of low surface energy. Thin layers are unstable on areas of low surface energy. Fatty oils and fatty acids are prevented from spreading on metal surfaces by the great reduction in the surface energy of the metal which is brought about to some distance in advance of the spreading layer by the breaking away of an expanding ring or by the condensation of vapors.

Piston Temperatures in a Solid-Injection Oil Engine, G. F. Mucklow (Engineering [London], 134 (1932), No 3493, pp 745-747, figs 8).—Studies conducted at the University of Manchester are reported the object of which was to determine the temperature of the piston of a solid-injection heavy oil engine at a number of points distributed over the crown and walls and under a variety of running conditions.

With reference to piston temperatures at different loads, the highest temperature was reached at a point in the middle of the central knob of the piston, increasing more than 50 per cent from less than half load to full load. The temperatures at other points in the central knob were also very high. At points on the edge of the crown the temperature was considerably below that of the central knob. The temperatures recorded at points below the first set of rings and in the piston skirt showed but little variation with changes of load. At points on the thrust slipper of the piston the temperaure was in each case slightly below that of the corresponding point in the upper slipper.

As the jacket outlet temperature was raised the temperature at points on the central knob decreased. At points close to the edge of the crown the temperature remained very nearly unchanged. The temperatures at points in the piston skirt increased with increase in jacket outlet temperature, the rise being appreciably greater for points situated in the upper side of the piston skirt.

Removal of the diaphragm plate caused a slight fall in piston temperature, the cooling effect increasing with increase of load. The decrease in temperature was greatest at points situated in the piston knob.

Dairy Barn Ventilation, L. G. Heimpel (Macdonald Col., McGill Univ., Farmers' Bul. 5 (1932), pp 43, figs 14).—The results of studies over three winters of the performance of the ventilation systems in 15 dairy barns near Montreal are reported. Only natural draft ventilation was investigated.

The studies included observations of outside and inside temperatures, the latter being taken at ceiling level, at floor level, and at mid-height; anemometer measurements of the velocity of the outgoing air in the outtakes which, together with the cross-section area of the flue apertures, permitted the calculation of the rate of air change; relative humidity determinations, a measure of efficiency in that it is an indication of the purity of the air in the stable; air-movement studies may by means of white smoke-like fumes secured by allowing two strong gaseous chemicals to come together in the air.

The conclusion was drawn that multi-outtake flues are unnecessary. Satisfactory ventilation can be secured with only a single outtake for even very large stables. Under normal winter weather conditions the passing of about 50 cu ft of air per minute per a. u. (1,000 lb live weight) through a stable is sufficient to maintain very good air conditions.

The circulation of stable air is controlled and caused by the animals housed in it more than by the ventilation system. As soon as the air comes in contact with an animal, it is warmed and immediately rises to the ceiling, and, in order to replace air thus moved, some cool air flows along the floor to be warmed and sent to the ceiling in turn. Where cattle are stabled in rows, therefore, there is a continual strong convection current from the cattle to the ceiling, along the ceiling to the nearest cold wall, then down the wall and across the floor back to the animal. Usually there are also present other convection currents, at right angles to those from the cattle to the nearest cold wall, in which there is usually a strong movement of air along the floor in one direction and along the ceiling in the opposite direction.

Outtake flues do not cause harmful drafts. There is of course a slow movement or gravitation toward the outtake which is not noticeable at distances over 2 ft from the opening. While concentration of outtake has no harmful effect, concentration of intake is very harmful and therefore not permissible. Intake flues must be distributed around the stable in order to prevent drafts and to produce good distribution of incoming air.

The amount of air a given ventilation system will pass through a stable is controlled by the capacity of the outtake. No more air will come in at the intakes than is necessary to replace that removed by the outtake. Floor outtakes, or the type used in the King system of ventilation, do conserve considerable stable heat over that conserved by ceiling outtakes (Rutherford type) for a given amount of air handled.

Regardless of the type of system under consideration, however, the single outtake system has been proved to be vastly superior, both in performance and economy, to systems having a number of outtake flues and ventilator heads on the barn roof.

Practical information is given on the planning and construction of the single outtake King system of ventilation and on the regulation of the system.

Comments on Depreciation and Repairs of Combine Harvesters and Tractors on the Canadian Prairies, E. G. Grest (Sci. Agr., 13 (1932), No 1, pp 26-35).—An attempt is made in this brief contribution from the Canadian Department of Agriculture to develop a satisfactory method for the calculation of depreciation on combines and tractors in western Canada under average prevailing conditions of operation.

Book Review

THE GAME OF PLANNING A HOUSE. By Dan Scoates. D. Scoates, P. O. Box 2108, College Station, Texas, 1933. Cloth, 6x9 in, 150 pp, 53 figs, tables, $2. This volume is written especially for the layman and offers a solution to a very perplexing problem which confronts almost every one sometime during his life, that is, the designing of a house. The layman's limitations are kept continually in mind in the preparation of this work. The contents of this volume are based on years of experience as a teacher in colleges, and as a designer and builder. In addition, considerable original specification work has been done, not only by the author but by his students and co-workers as well. This volume will be a source of considerable help to those undertaking to build small homes to students in colleges and universities studying small house design, and to the building materials trade in assisting their customers. Orders for the book should be sent direct to the author.

S.A.E. HANDBOOK (1933 Edition). Society of Automotive Engineers, 29 W. 39th St., New York, N. Y. Cloth, 5x8 in, $5. This edition of this well-known automotive engineering handbook is the first to be issued in the improved larger size. It contains the standards and recommended practices that have been adopted to date by the Society of Automotive Engineers, and that are referred to and used extensively in the automotive and associated industries both in America and abroad. Because of their wide recognition and use, many of the specifications, such as the steels and non-ferrous metals, the screw threads, bolts and nuts, petroleum oil classifications, etc., are also used extensively by other industries. A number of them conform to American Standards approved under the procedure of the American Standards Association. Loose-leaf copies of individual specifications are available at nominal cost from a limited stock carried by the Society. Individual specifications in quantity lots may also be purchased from the Society and prices will be quoted on individual orders. The S.A.E. Handbook is a valuable reference and guide for all purposes to which the specifications therein may be applied.

Publications Received

"Cooperative Studies of the Application of Electricity to Agriculture" is the title of Rural Electrification Progress Report No 9, issued recently in mimeograph form by the Idaho Committee of the Relations of Electricity to Agriculture, Hobart Beresford (Mem. A.S.A.E.), secretary and project director, Moscow, Idaho.

"Value of Ice in Air-Cooled Storage" is the title of Bulletin No 379 issued recently by the Purdue University Agricultural Experiment Station, Lafayette, Indiana. The authors are Clarence E. Baker, department of horticulture, and I. D. Mayer (Mem. A.S.A.E.) associate in agricultural engineering.

"The Cornell Apple Washer," by B. A. Jennings (Mem. A.S.A.E.), professor of agricultural engineering and agricultural extension, is the title of Mimeo Bulletin No 236 recently issued by the Department of Agricultural Engineering, New York State College of Agriculture at Cornell University, Ithaca, New York.

"Electric Soil Heating (1933 studies)" is the title of Report No 8 recently issued by the National Rural Electric Project, College Park, Maryland. The authors are Geo. W. Kable (Mem. A.S.A.E.), and A. V. Krewatch (Mem. A.S.A.E.), director and electrical engineer, respectively, of the National Rural Electric Project.

"Final Report of the National Rural Electric Project" is the title of Report No M-16 just issued by the National Rural Electric Project, College Park, Maryland, in mimeographed form as the final report on that project.

"Soil Erosion—Cause and Methods of Control," by H. B. Roe, agricultural engineer, Minnesota Agricultural Experiment Station, is the title of Special Bulletin 160 (1933) issued by that Station, and is a comprehensive treatise on the subject, designed to be of practical value to the agriculture of Minnesota.

A.S.A.E. and Related Activities

A.S.A.E. Annual Meeting on the Great Lakes

FOR three consecutive years it has happened that the annual meeting of the American Society of Agricultural Engineers has been held during extremely warm weather. At the meeting this past June, many of those in attendance expressed a desire to have the meeting next year held in a cooler clime.

The Council of the Society, in an endeavor to satisfy this desire, has recently voted to accept an invitation extended at the last annual meeting by H. H. Musselman, on behalf of the agricultural engineering department of Michigan State College, to hold the 1934 annual meeting "somewhere in Michigan."

Three proposals were subsequently submitted to the Council. One provided for holding the meeting at a hotel a Detroit. Another provided for part of the meeting being held on land, and about one day on the water. The third proposal—and the one just approved by the Council—provides for holding the entire meeting, aside from the inspection trips, on the Great Lakes. In making its decision to hold the meeting on the Great Lakes, the Council was influenced largely by the expressed desire of quite a number of members in attendance at the Purdue meeting that the meeting be held on the water.

In the preliminary plans for the meeting, which does not of course include the program features, Mr. Musselman and his associates have already made considerable progress and have mapped out an interesting and attractive trip. Following is a brief outline of what they are proposing:

It is planned to devote Monday, June 18, to an inspection trip to points of outstanding agricultural engineering interest in the vicinity of Detroit. A trip of 100 to 120 miles, probably by buses, will start from Detroit about 11:00 a.m. The return from this trip will be about 5:30 o'clock in the afternoon.

If satisfactory arrangements can be made with the boat company (and this will shortly be investigated), those attending the meeting will, before leaving on the inspection trip, park their cars in a garage at the boatdocks, be registered on board the boat, and assigned to their staterooms. On returning from the inspection trip the members will spend the night on the boat, and the evening may be devoted to sightseeing about Detroit, to informal group conferences, etc.

The boat will leave Detroit at 11:00 a.m. on Tuesday, June 19, so that those who do not arrive in time for the inspection trip on Monday, can plan their arrival Tuesday morning in time to catch the boat before departure. After leaving Detroit the direction will be north through Lake St. Clair and St. Clair River to Port Huron, and then along the west shore of Lake Huron, arriving at Mackinac Island early Wednesday forenoon. There will be a stop-over of about three hours at Mackinac Island, and on leaving there the boat will proceed to Ste. St. Marie. The trip through the Soo Canal and lock will be made during the late afternoon and evening of Wednesday. The boat will then enter Whitefish Bay in Lake Superior, turn around, and make the return trip through the Soo Canal late at night. It will then return to Mackinac Island Thursday forenoon, where a five-hour stop-over will be arranged, with possibly a meeting session at the Grand Hotel. Leaving Mackinac Island Thursday afternoon, the boat will arrive at Detroit on Friday about noon.

To complete the five-day program, consideration is being given to a trip to Greenfield Village, the famous museum which Henry Ford has been developing at Dearborn, the start of the trip to be made as soon as the boat docks at Detroit. This trip will round out and complete the meeting.

In the foregoing no attempt has been made to indicate arrangements for sight-seeing and the meeting sessions, but this has been very well worked out by Mr. Musselman.

One of the attractive features of this plan of holding the annual meeting on the Great Lakes is that it combines an annual meeting with a delightful boat trip. While all details of the cost of the trip have not been completed, it appears that the total cost of the boat trip will exceed by about $15.00 the cost of staying at a hotel in Detroit. Besides it will give those who attend the pleasure of a boat trip at a much lower cost than would be possible ordinarily.

Those members of the Society who have considered the details of the proposed plan are quite enthusiastic about it, and it is believed that members generally will be enthusiastic about it as the plans are unfolded to them month by month.

For Engineers Seeking Government Work

THE U. S. Treasury Department will look with much disfavor on those architects or engineers who retain legal counsel in Washington to aid them in securing professional contracts from the Department; in fact, it will be the disposition of the Department to eliminate such architects and engineers from consideration altogether. This announcement was recently made by Assistant Secretary of the Treasury, L. W. Robert, Jr., who has requested the American Institute of Architects and American Engineering Council to make the attitude of his office widely known.

New ASAE Members

Forrest L. Bocock, farmer, Dublin, Virginia.

George K. Harnsberger, farmer, Port Republic, Virginia.

Robert B. Hickok, erosion control engineer, C.C.C. Camp 71 E, Evansville, Wis. (Mail) 217 W. Main St.

Roy C. Hubbard, 401 Cummings St., Fort Worth, Texas.

Edward W. Mundie, engineering department, West Virginia Pulp & Paper Co., Covington, Virginia. (Mail) 105 McCurdy St.

H. J. Stockwell, technical advisor, Civilian Conservation Corps, Camp 56-E, Pittsfield, Ill. (Mail) CCC 1660.

W. Albert Towler, Jr., farmer, Charlotte Court House, Virginia.

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the September issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Samuel Maxwell Beane, milk tester, Fauquier Dairy Herd Improvement Association, Catlett, Virginia.

John P. Billingsley, high school instructor, King George, Virginia.

Wayne H. Lowry, agricultural engineer, C.C.C. Camp 57-E, Albany, Missouri.

Evelyn H. Roberts, research specialist in home economics, State College of Washington, Pullman, Wash. (Mail) Home Economics Building.